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Sloman

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(54) **RESPONDING TO AN EXPLOSION LOCAL TO AN ARMOURED VEHICLE**

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CPC F41H 7/042; F41H 7/044
USPC 89/36.08, 36.17
See application file for complete search history.

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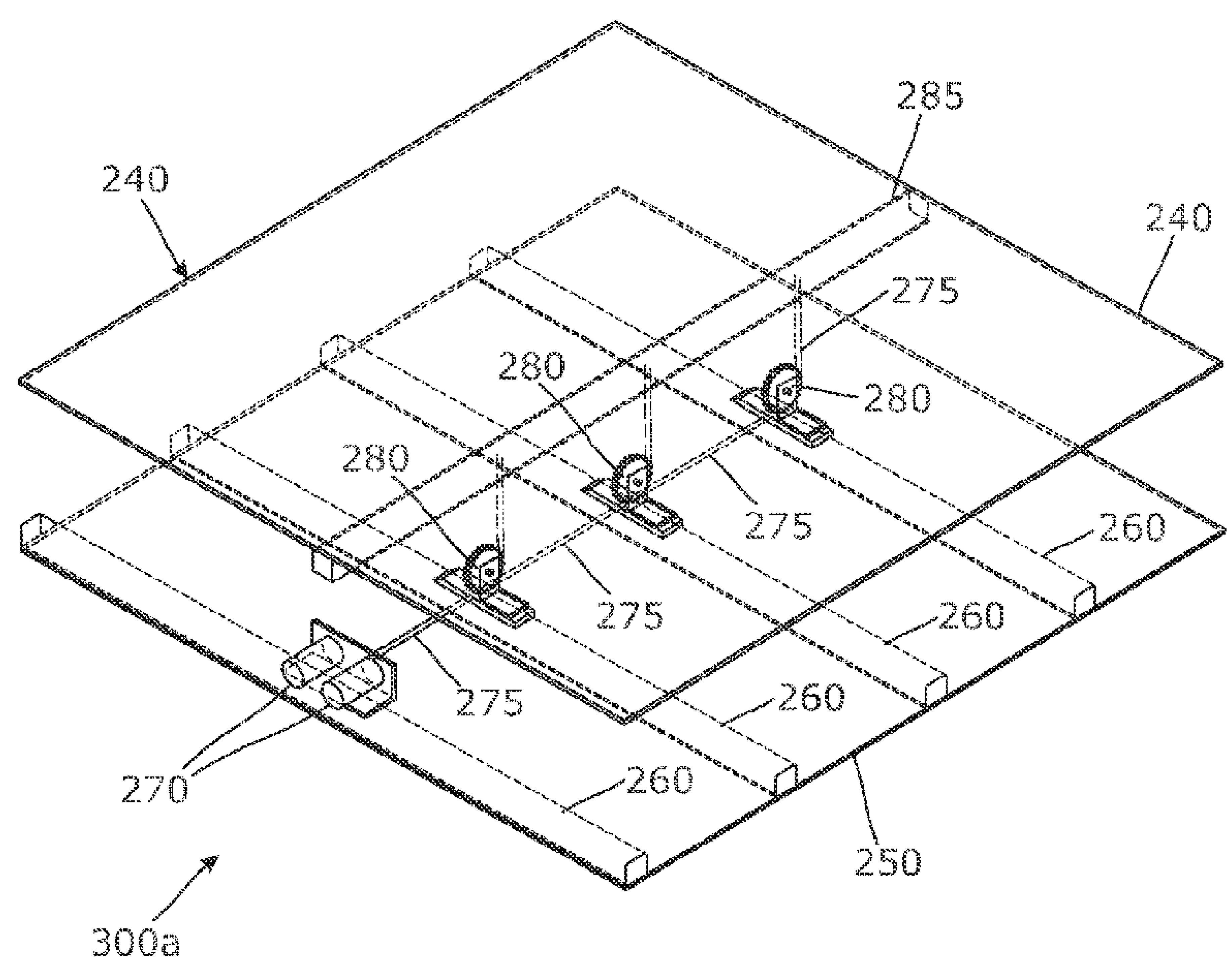
(57) **ABSTRACT**

A blast countermeasure for a vehicle, such as an armoured vehicle, is provided. The blast countermeasure comprises: at least one explosive; a detonator for detonating the explosive; and at least one reflector, located at least partially above the at least one explosive, for reflecting a shock wave generated by detonation of the at least one explosive groundwards in order to apply a groundwards force to the vehicle.
The vehicle may comprise: control circuitry configured to respond to detection of an explosion local to the vehicle by activating an actuator to generate a groundwards force and cause a cabin floor of the vehicle to move groundwards.

20 Claims, 15 Drawing Sheets



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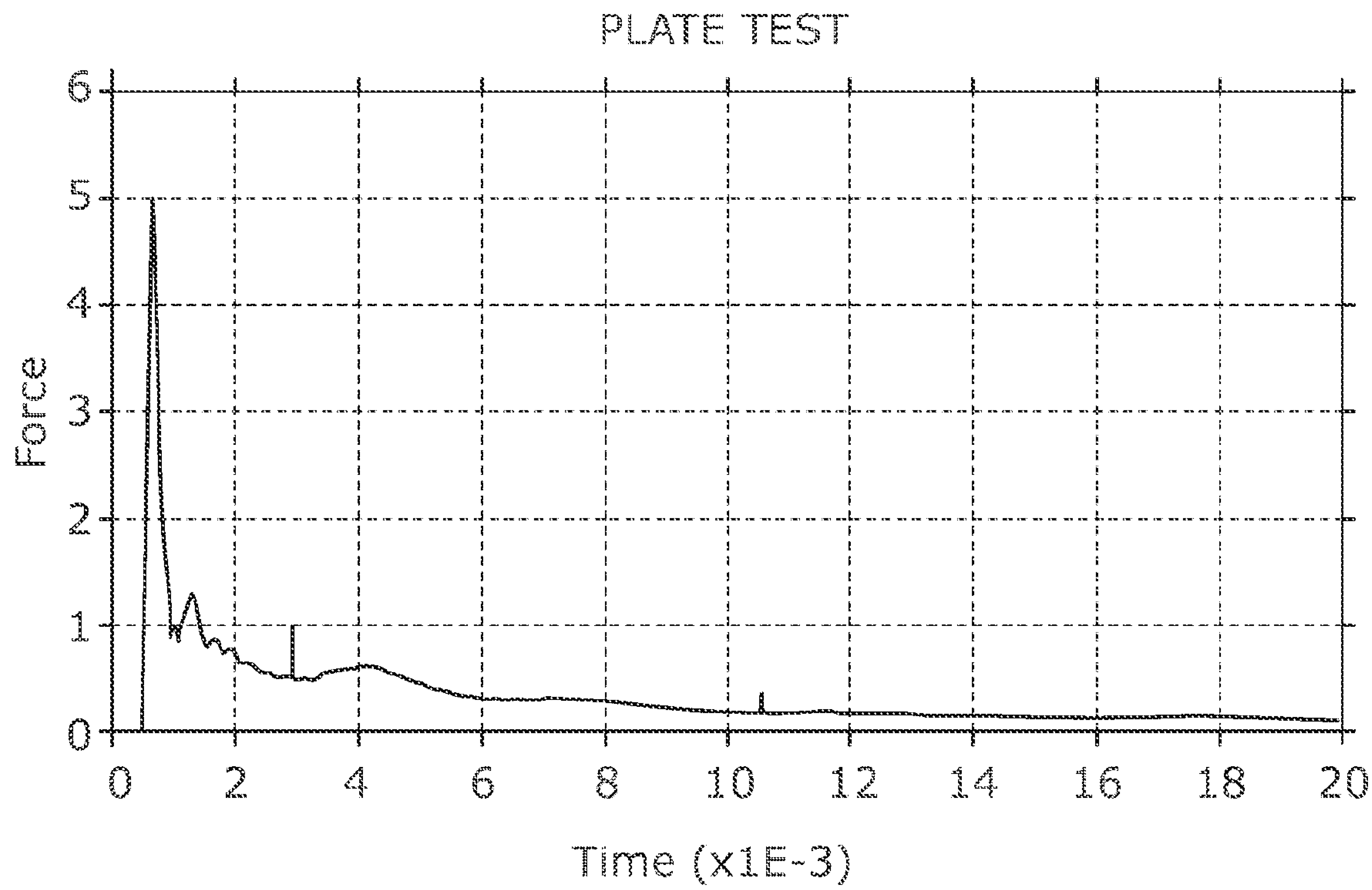
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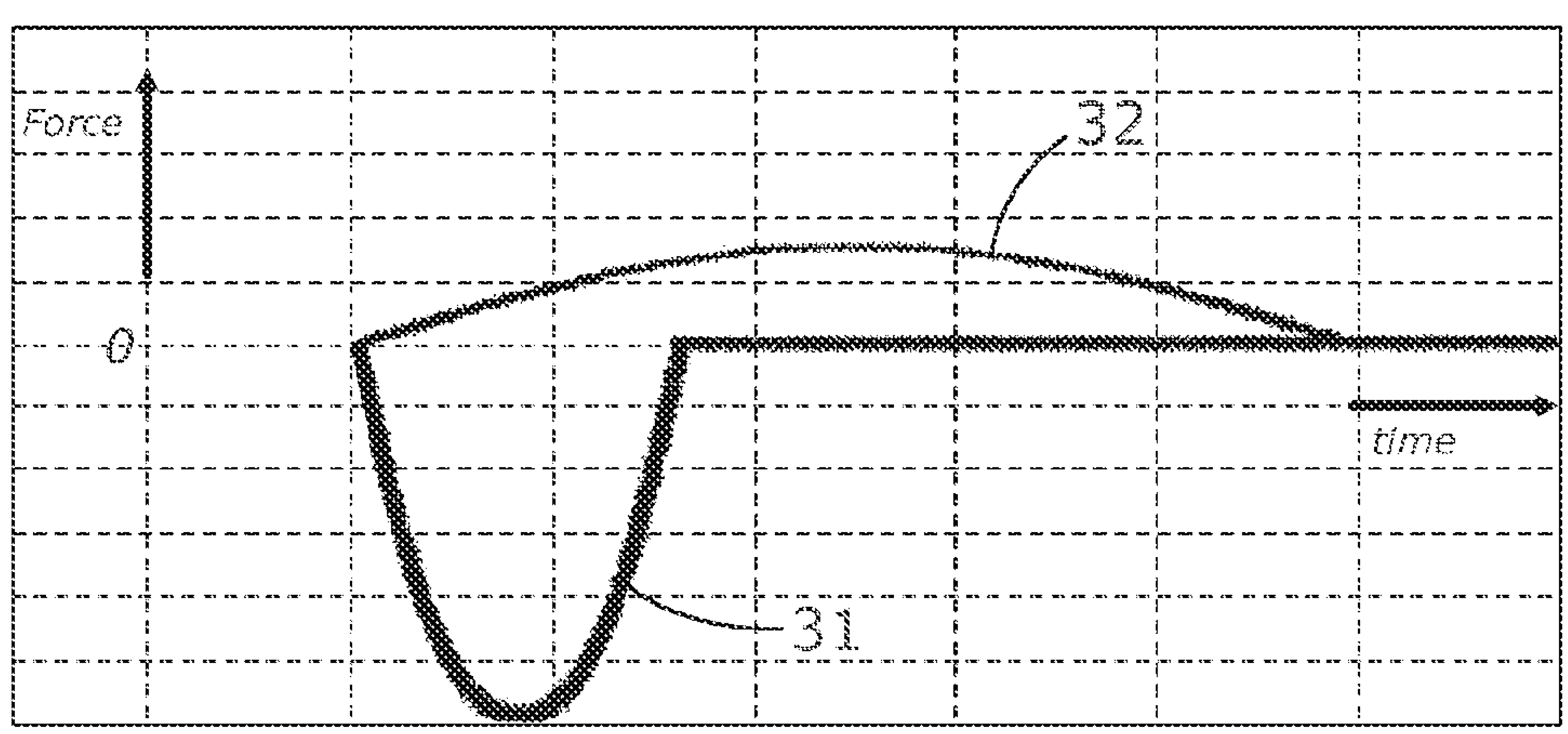
16
18
20

Fig. 1A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time
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31

Fig. 1B

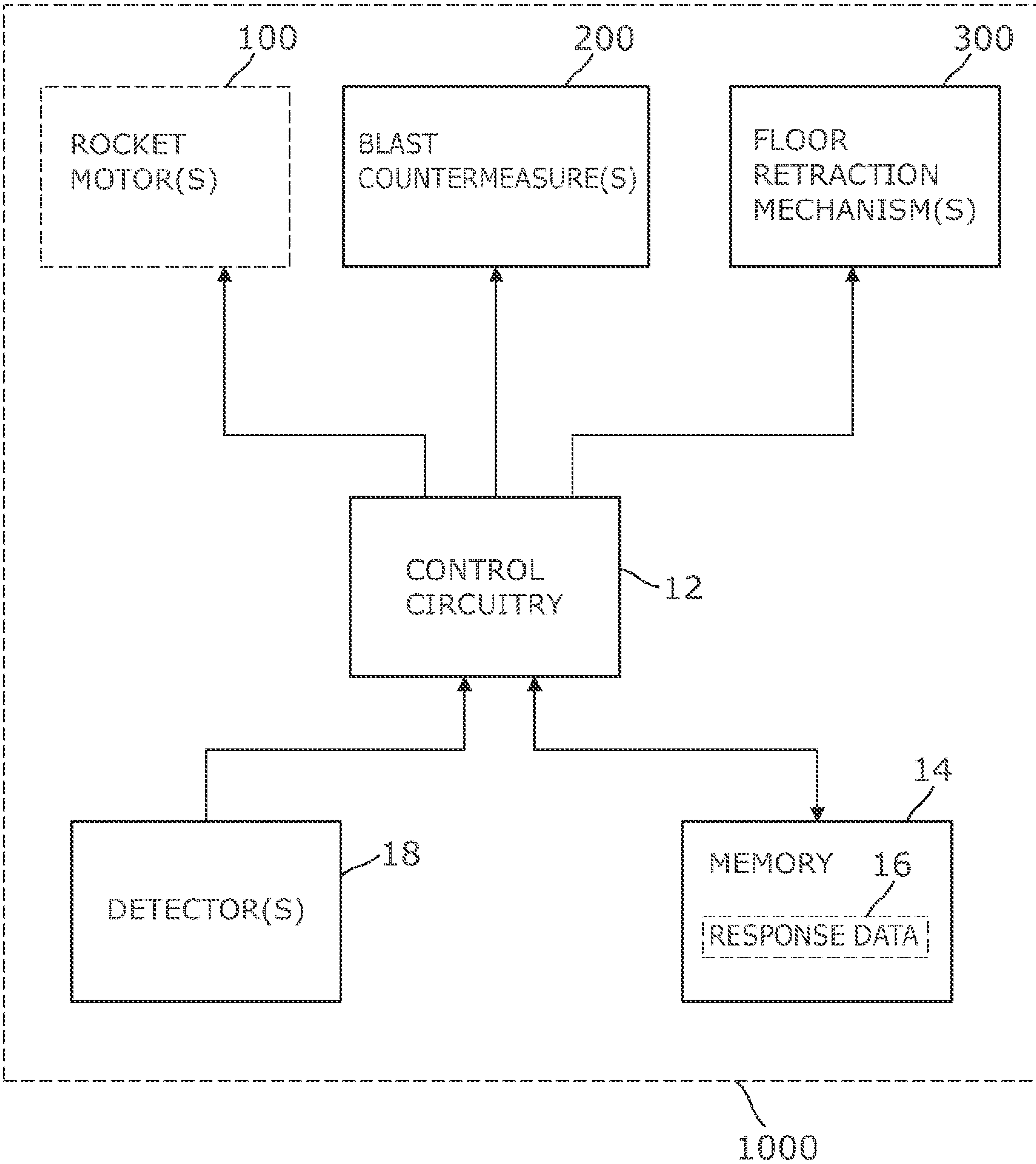
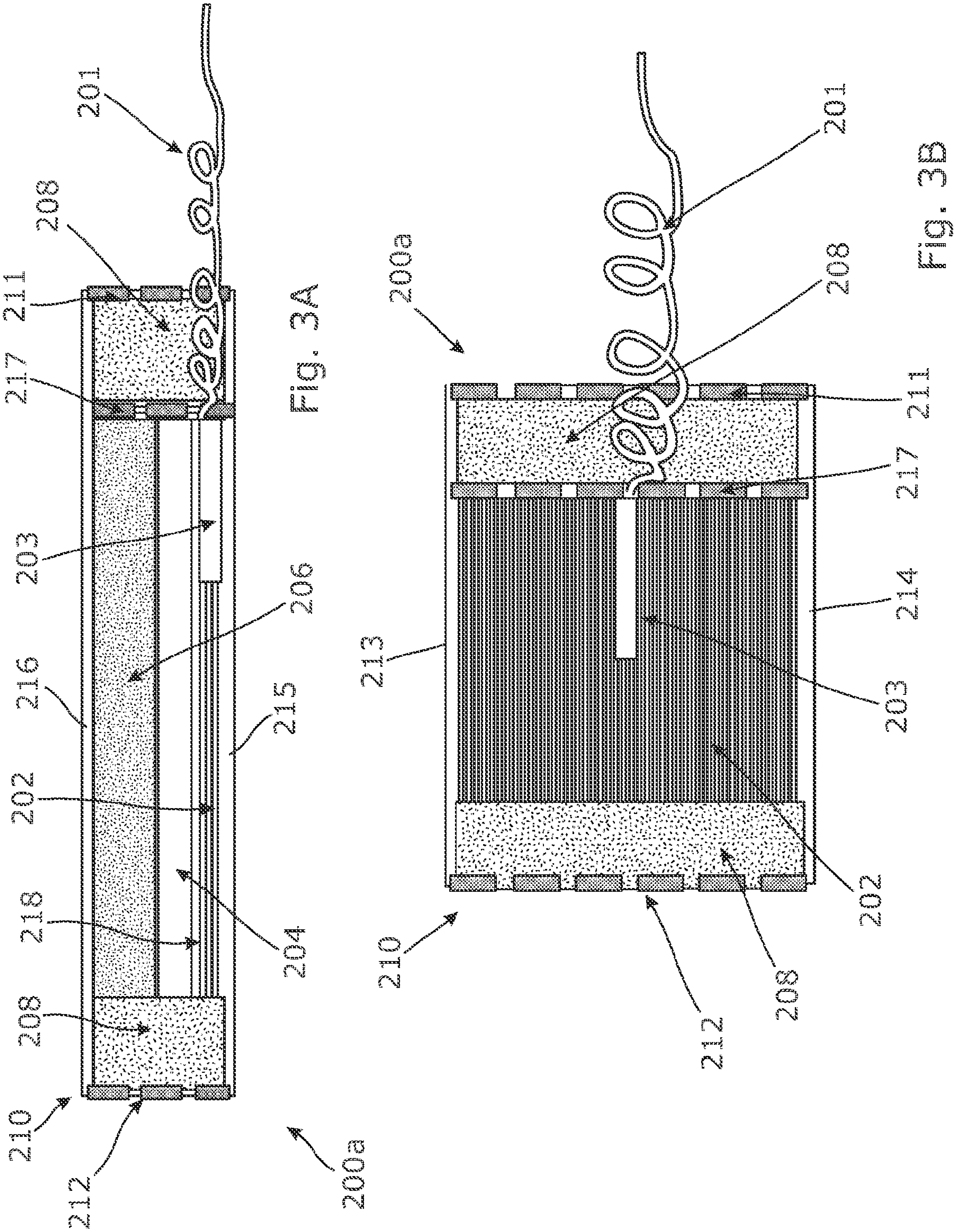

100
200
300
ROCKET MOTOR(S)
BLAST COUNTERMEASURE(S)
FLOOR RETRACTION MECHANISM(S)
CONTROL CIRCUITRY
12
14
18
DETECTOR(S)
MEMORY
16
RESPONSE DATA
1000

Fig. 2


201
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206
216
202
218
204
215
208
210
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200a
200a
201
208
211
217
213
214
203
202
210
212
208

Fig. 3A

Fig. 3B

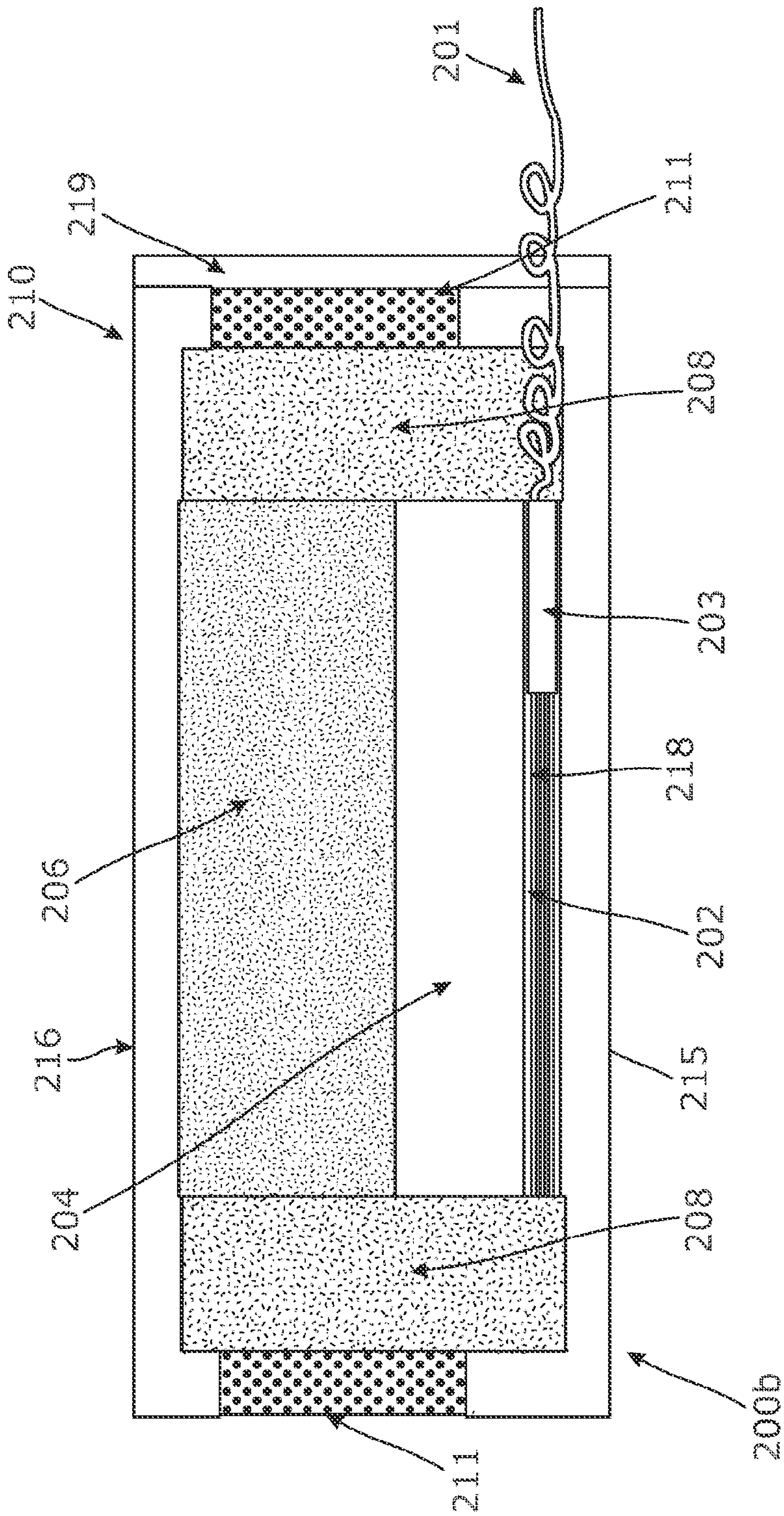
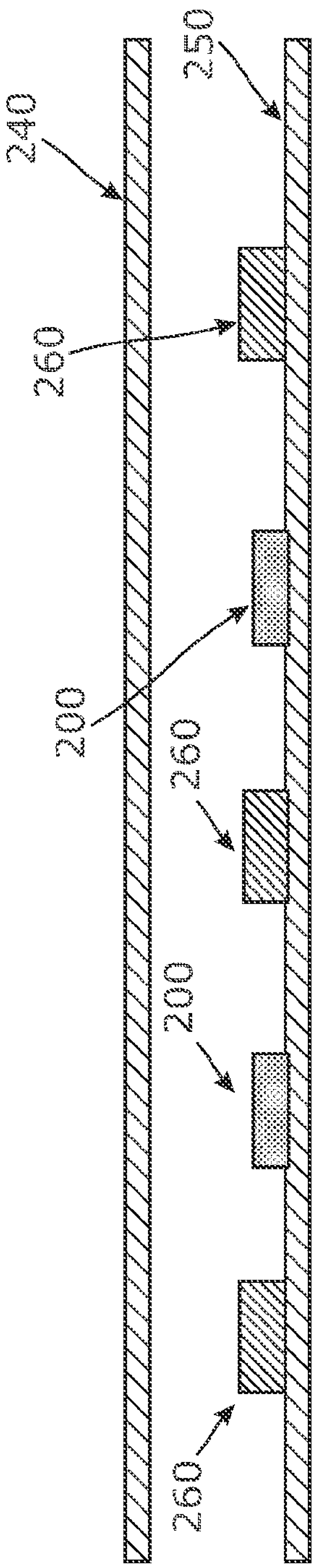


Fig. 3C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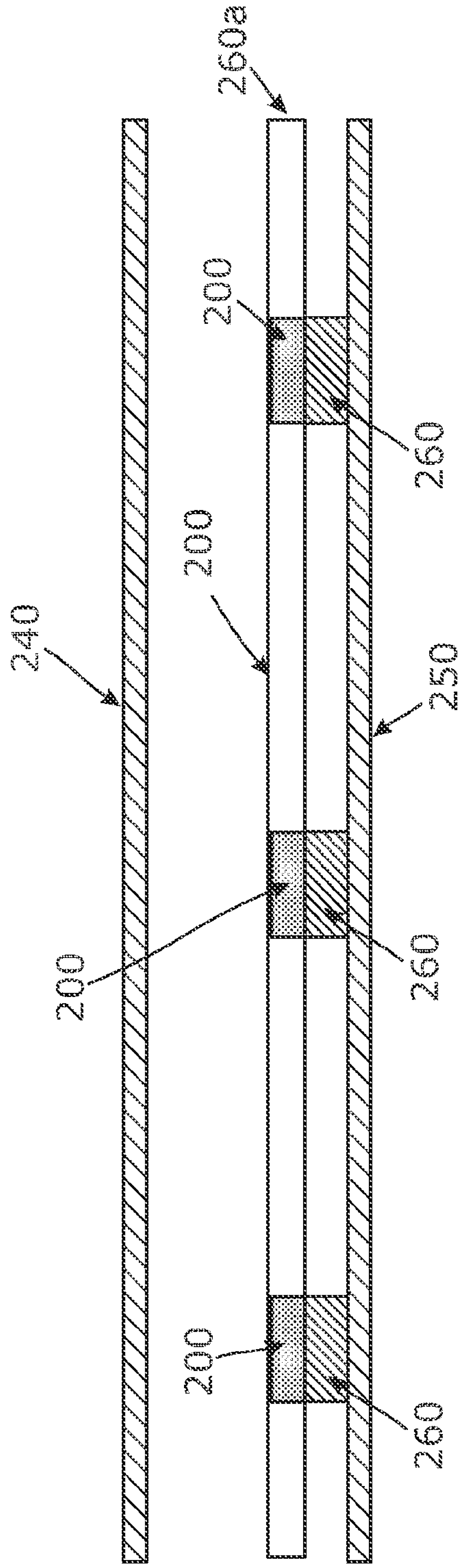
250
260
200
260
200
260

Fig. 4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200
260

Fig. 5

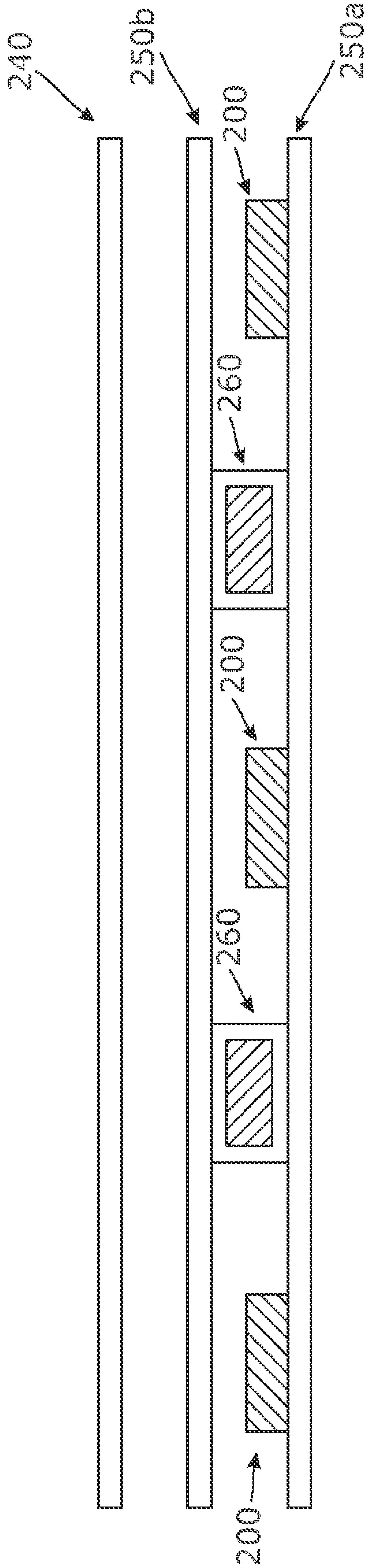


Fig. 6

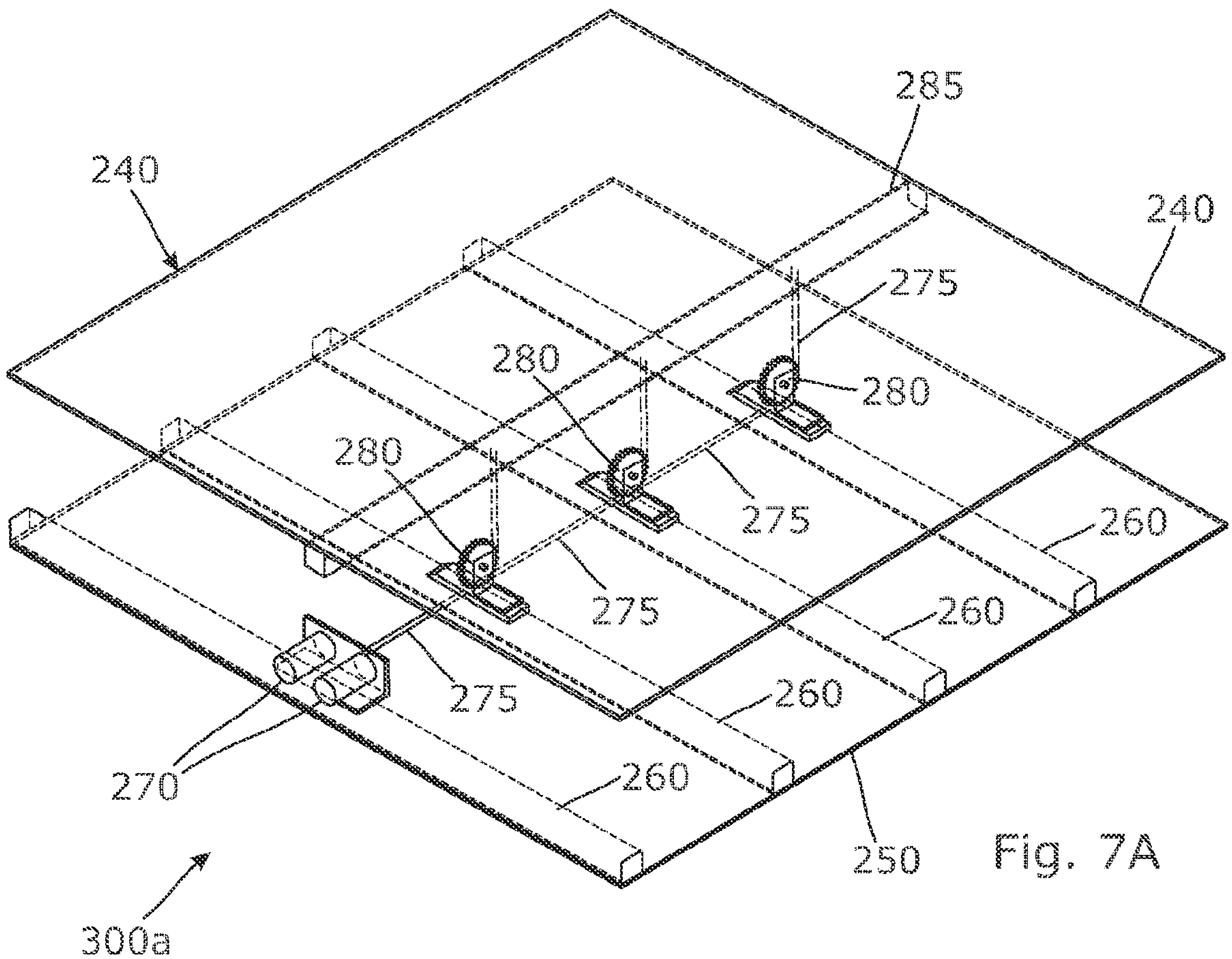


Fig. 7A

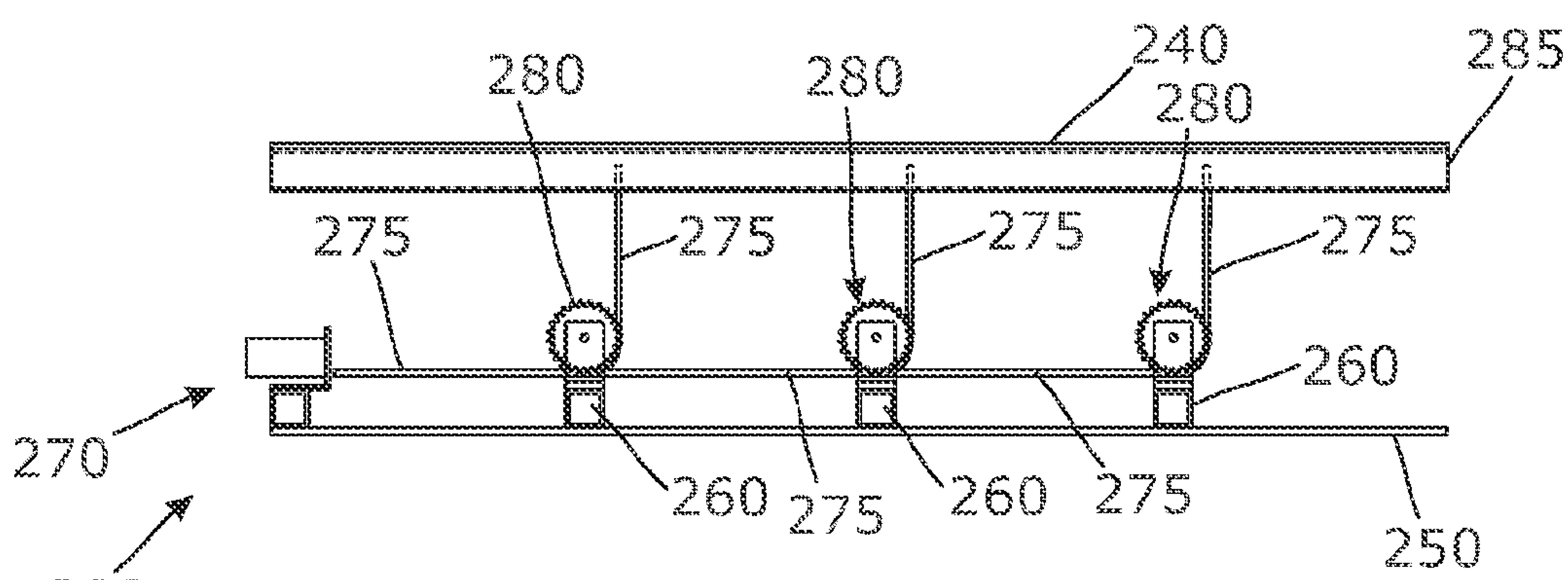


Fig. 7B

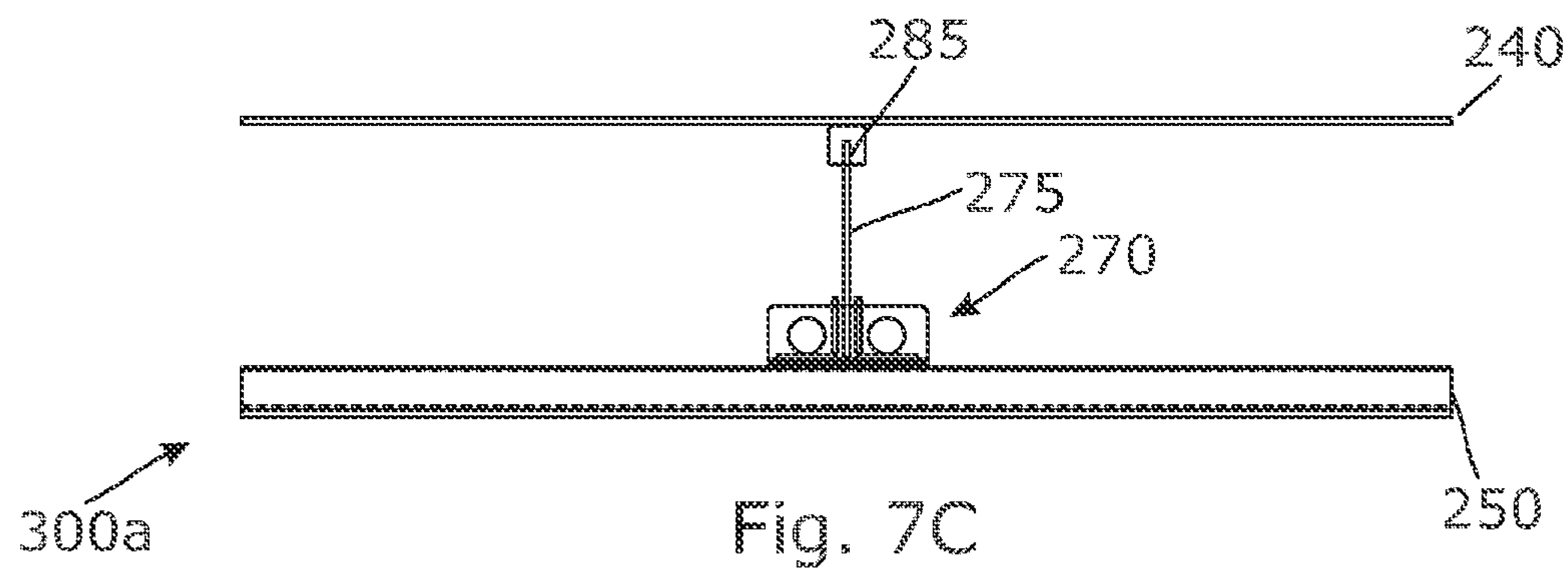


Fig. 7C

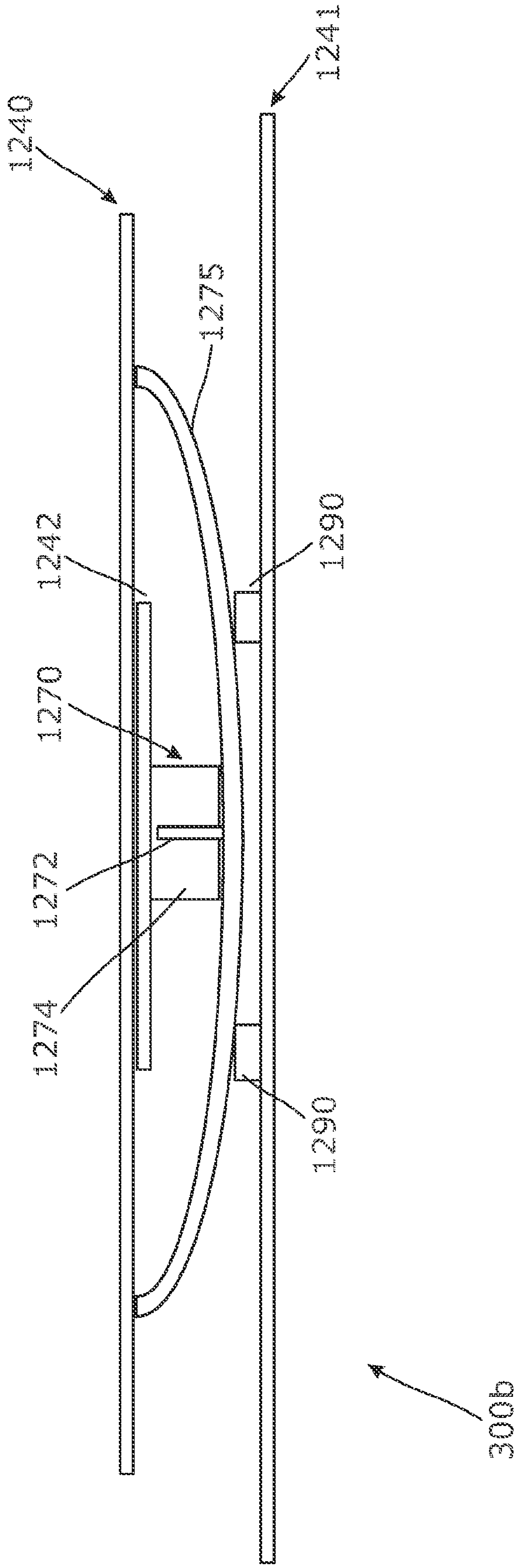
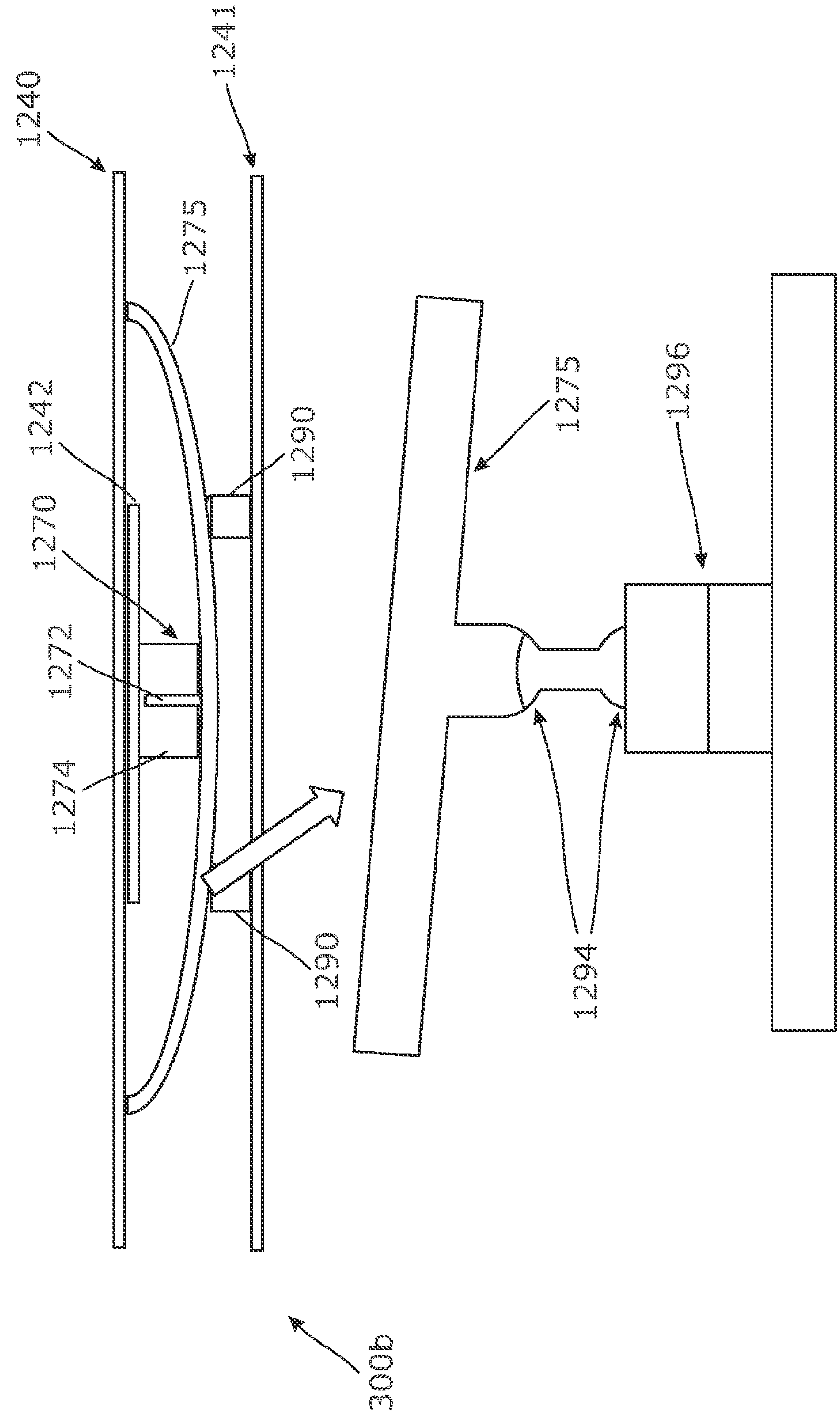


Fig. 8A


1240
1241
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1275
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1241
1294
300b

Fig. 8B

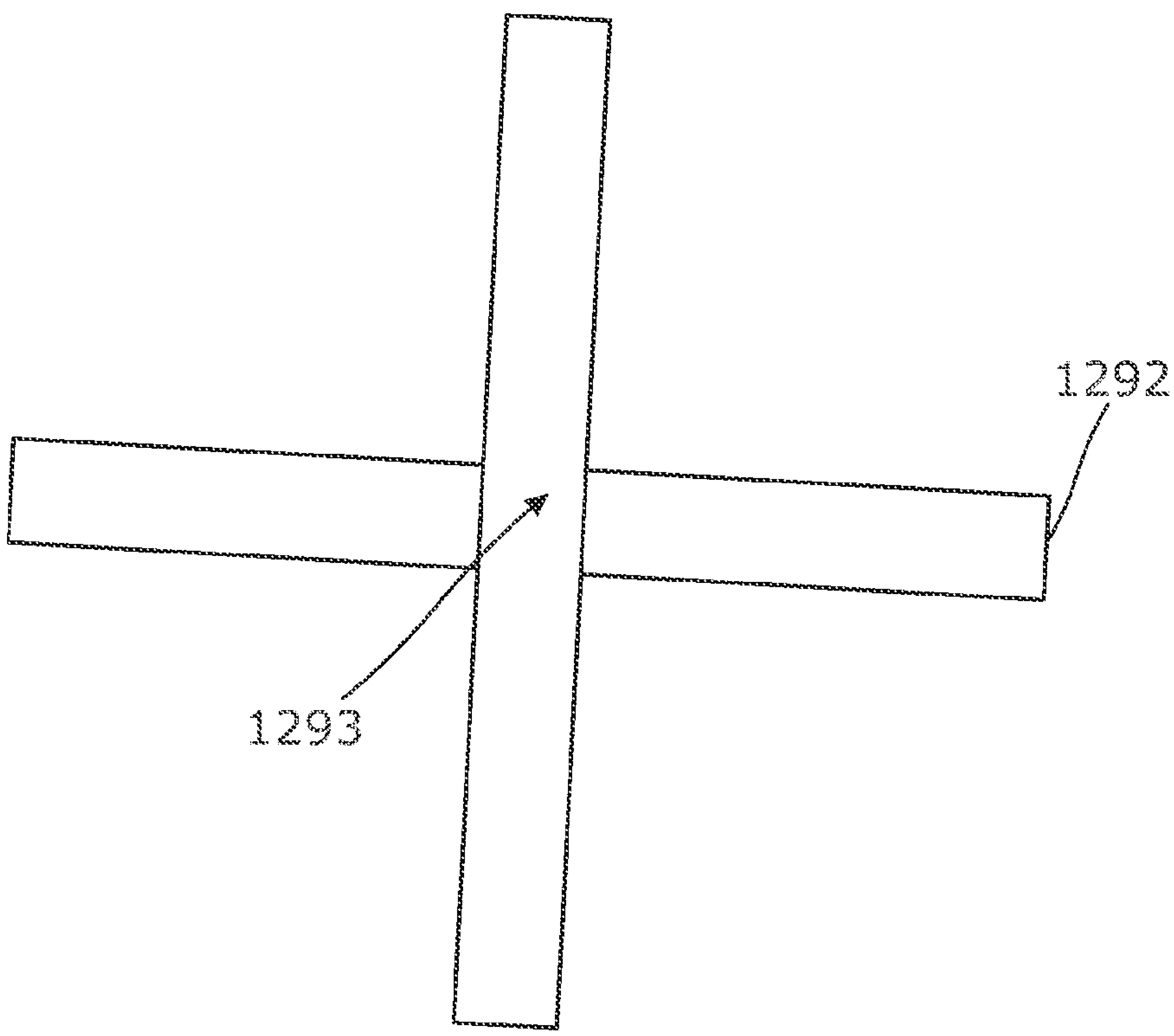

Fig. 9

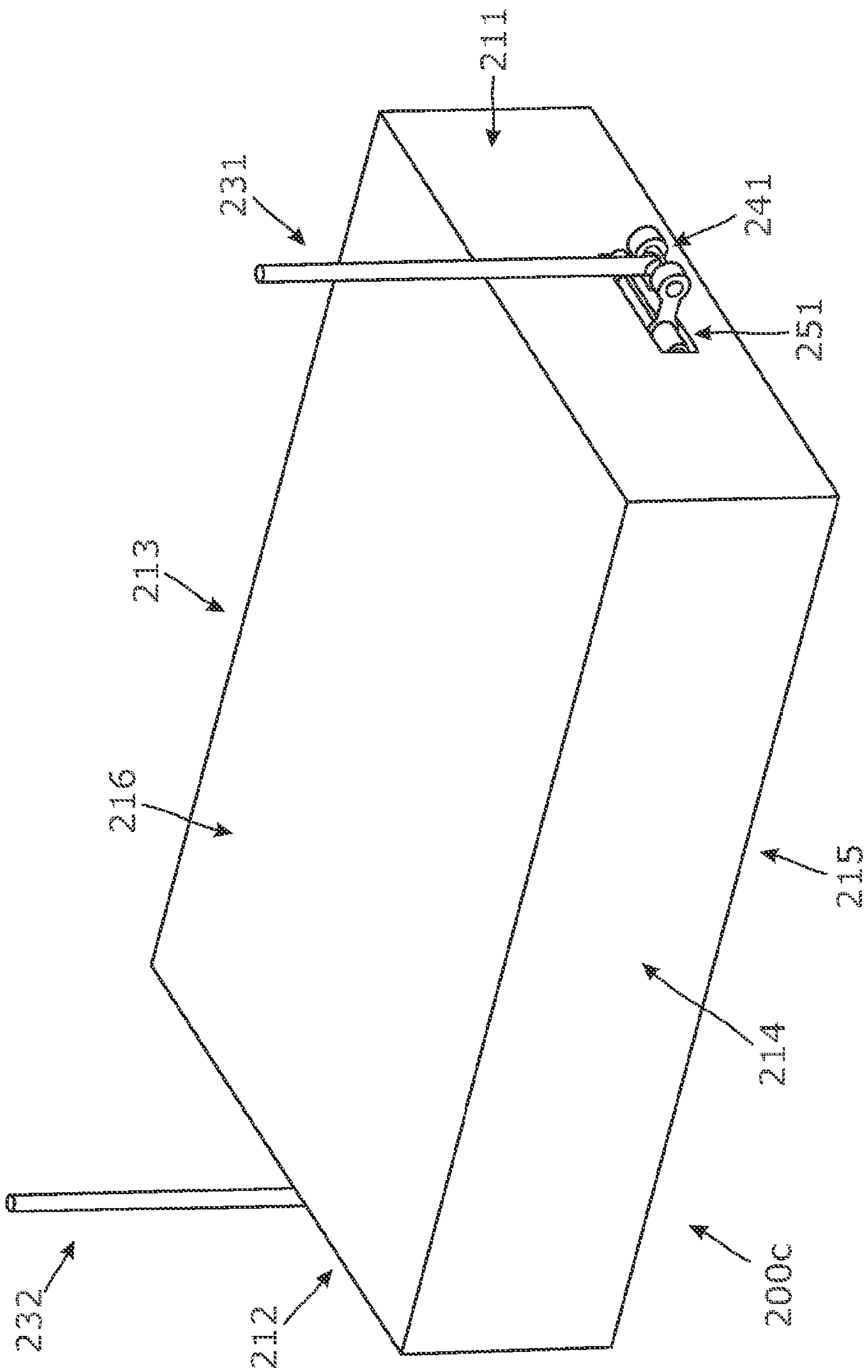

Fig. 10

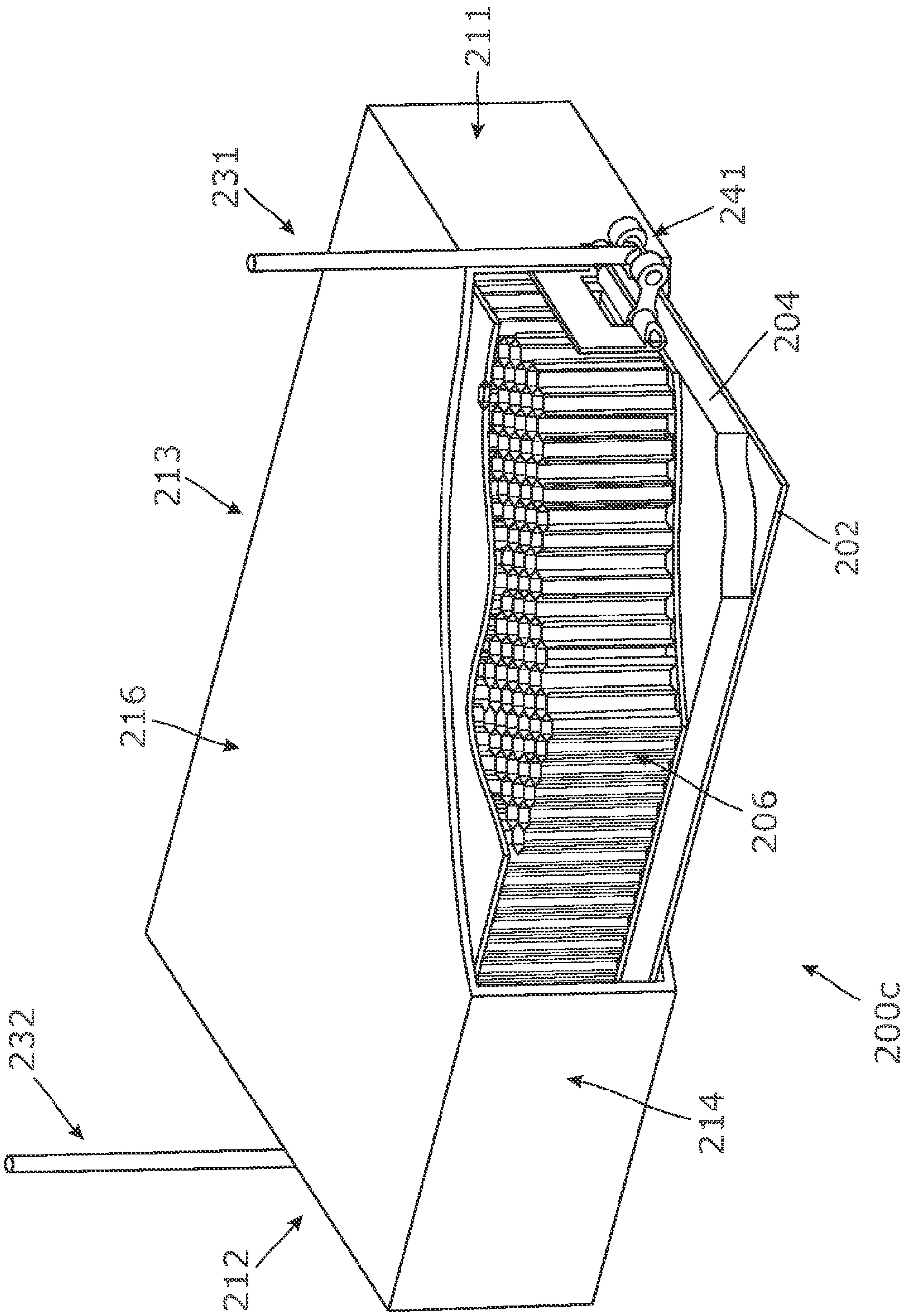

Fig. 11

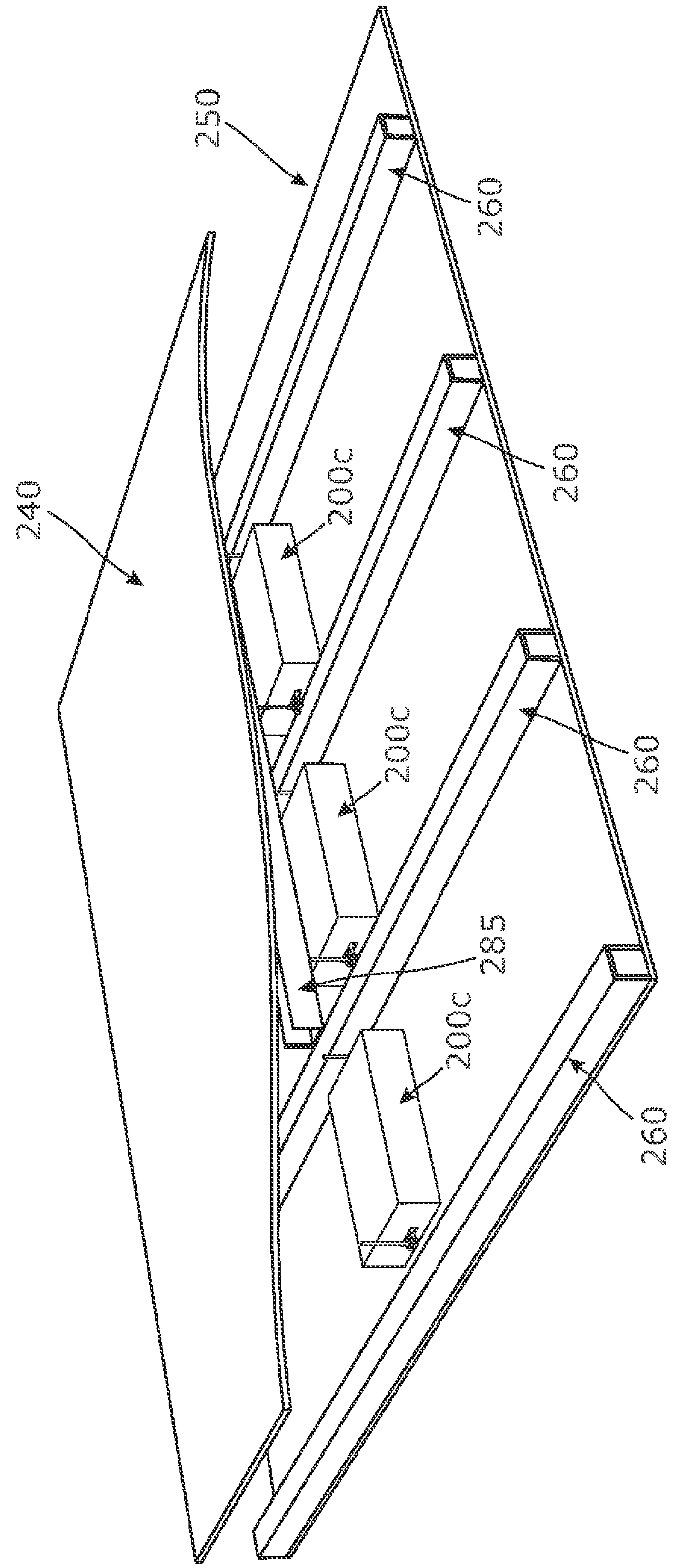

Fig. 12

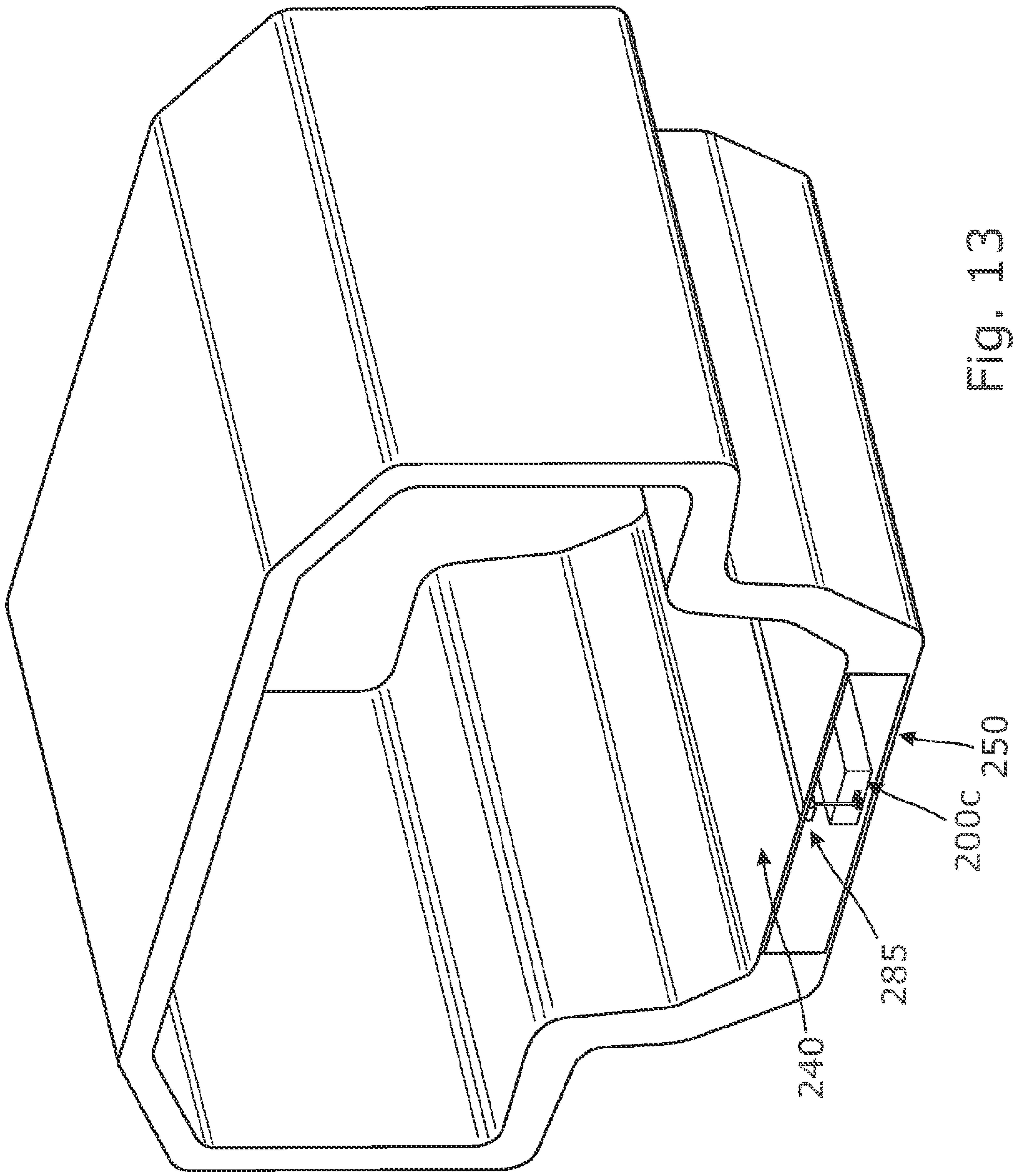

Fig. 13

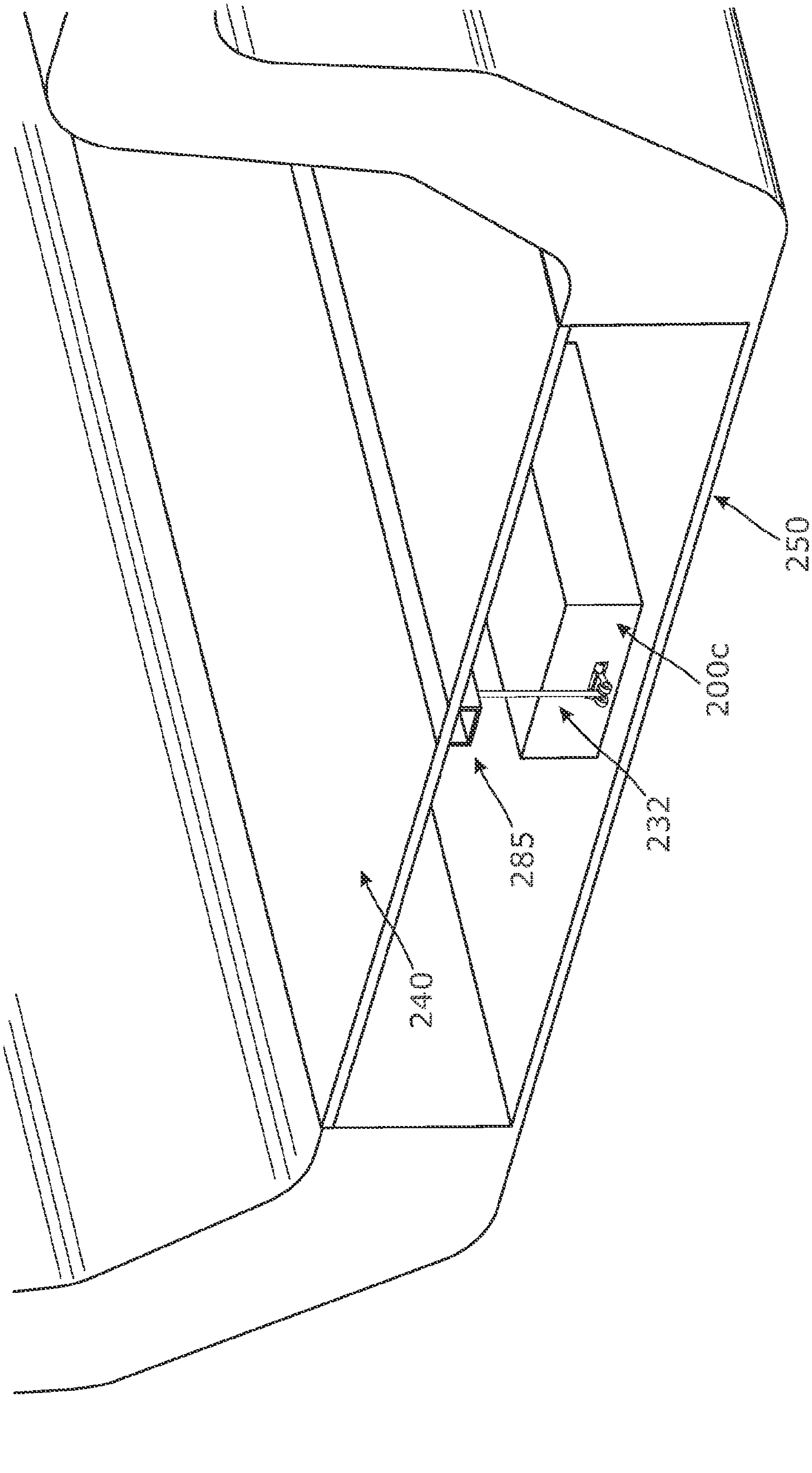

Fig. 14

RESPONDING TO AN EXPLOSION LOCAL TO AN ARMOURED VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is related to and claims benefit of the earliest available effective filing date from the following applications: The present application constitutes a National Phase application of PCT Application Number PCT/GB2020/051970, filed Aug. 18, 2020, which claims priority to Patent Application No. GB1911943.7, filed Aug. 20, 2019, whereby the above-listed applications are incorporated herein by reference in their entirety.

TECHNOLOGICAL FIELD

Embodiments of the present invention relate to responding to an explosion local to an armoured vehicle. In particular, they relate to performing protective actions to mitigate the effect of such an explosion on the occupants of an armoured vehicle.

BACKGROUND

An explosive event can cause significant trauma to a vehicle and/or a vehicle's occupants. In order to protect the occupants of the vehicle from shrapnel and blast emanating from an explosive such as a bomb, mine or improvised explosive device (IED), some vehicles comprise armour.

The armour may protect the occupants against injury caused directly from the shrapnel and blast effects. However, depending upon the size of the explosive, some aspects of the vehicle (such as the base of the vehicle if the explosion occurs underneath the vehicle) can be very heavily damaged. Furthermore, an explosion underneath or to the side of a vehicle may cause the vehicle to accelerate rapidly into the air, resulting in injury to the occupants either when being accelerated upwards or when the vehicle lands on the ground.

BRIEF SUMMARY

According to various, but not necessarily all, embodiments there is provided a blast countermeasure, comprising: at least one explosive; a detonator for detonating the explosive; and at least one reflector, located at least partially above the at least one explosive, for reflecting a shock wave generated by detonation of the at least one explosive groundwards in order to apply a groundwards force to the vehicle.

The blast countermeasure may further comprise: at least one mass, for providing a reactionary force upon detonation of the at least one explosive, to apply a further groundwards force to a vehicle.

The reflector may be located at least partially between the mass and the explosive. The mass may be situated on the reflector. The mass may be a non-gaseous mass.

The reflector may be made from at least one metal. The reflector may be substantially planar.

The blast countermeasure may further comprise: a housing arranged to house at least the reflector and the explosive. The housing may comprise a base. The explosive may be located on the base. The housing may further comprise at least one side wall. The side wall may include at least one vent for relieving pressure within the housing generated by detonation of the explosive.

The vehicle may be an armoured vehicle. The blast countermeasure may be for location between a blast shield of the armoured vehicle and a cabin floor of the armoured vehicle. The groundwards force may be applied to the blast shield.

The blast countermeasure may further comprise: a shock wave attenuator for attenuating a portion of a shock wave, generated by the detonation of the explosive, directed towards the cabin floor. The shock wave attenuator may comprise a resilient material.

The explosive(s) may include a high explosive and/or detonating cord.

According to various, but not necessarily all, embodiments there is provided a vehicle comprising the blast countermeasure.

According to various, but not necessarily all, embodiments there is provided a blast countermeasure for location between a blast shield of an armoured vehicle and a cabin floor of the armoured vehicle, the blast countermeasure comprising: at least one explosive; a detonator for detonating the explosive; a shock wave attenuator for attenuating a portion of a shock wave, generated by the detonation of the explosive, directed towards the cabin floor; and at least one mass, at least partially located between the shock wave attenuator and the explosive, for providing a reactionary force upon detonation of the explosive to apply a groundwards force to the blast shield.

The mass may be at least one non-gaseous mass. The blast countermeasure may further comprise a housing which is arranged to house at least: the shock wave attenuator, the mass and the explosive.

The housing may comprise a base. The explosive may be at least partially located between the mass and the base. The explosive may be located on the base.

The housing may comprise an upper wall.

The blast countermeasure may further comprise at least one side wall. The side wall(s) may include at least one vent for relieving pressure within the housing generated by detonation of the explosive. The blast countermeasure may further comprise a further shock wave attenuator located at least partially between the explosive and the side wall.

The blast countermeasure may further comprise at least one reflector located at least partially between the mass and the shock wave attenuator.

The shock wave attenuator and/or the further shock wave attenuator may comprise a resilient material.

The explosive may include a high explosive and/or detonating cord.

According to various, but not necessarily all, embodiments there is provided a vehicle comprising the blast countermeasure.

According to various, but not necessarily all, embodiments there is provided an armoured vehicle, comprising: a cabin floor; a blast shield located at the underside of the armoured vehicle; at least one detector for detecting an explosion local to the armoured vehicle; at least one blast countermeasure, located between the blast shield and the cabin floor, comprising at least one explosive; and control circuitry configured to respond to detection of an explosion local to the armoured vehicle by causing the at least one blast countermeasure to detonate the explosive and apply a groundwards force to the blast shield.

The blast countermeasure may be coupled to the cabin floor. The blast countermeasure may be configured to pull the cabin floor groundwards.

The blast countermeasure may be configured such that detonation of the explosive causes the blast countermeasure to pull the cabin floor groundwards. The blast countermeasure may be configured to apply the groundwards force to the blast shield and pull the cabin floor groundwards substantially simultaneously.

The blast countermeasure may be coupled to the cabin floor, at least in part, by one or more levers. The blast countermeasure may be configured such that detonation of the explosive causes the one or more levers to pull the cabin floor groundwards.

The armoured vehicle may comprise at least one elongate strengthening member, located between the cabin floor and the blast shield, for strengthening the resistance of the blast shield to an explosion. At least one blast countermeasure may be located on an elongate strengthening member.

The elongate strengthening member may include adjacent first and second elongate strengthening members. At least one blast countermeasure may be located between the adjacent first and second elongate strengthening members.

A plurality of blast countermeasures may be provided that are located between the blast shield and the cabin floor.

According to various, but not necessarily all, embodiments there is provided an apparatus, comprising: at least one detector for detecting an explosion local to an armoured vehicle; at least one blast countermeasure, for location between a blast shield of the armoured vehicle and a cabin floor of the armoured vehicle, comprising at least one explosive; and control circuitry configured to respond to detection of an explosion local to the armoured vehicle by causing the at least one blast countermeasure to detonate the explosive and apply a groundwards force to the blast shield.

According to various, but not necessarily all, embodiments there is provided an armoured vehicle, comprising: at least one detector for detecting an explosion local to the armoured vehicle; a cabin floor; at least one actuator, coupled to the cabin floor, for generating a force to cause at least a portion of the cabin floor to be pulled groundwards; and control circuitry configured to respond to detection of an explosion local to the armoured vehicle by activating the actuator to cause the cabin floor to move groundwards.

The armoured vehicle may further comprise a tractor configured to pull at least a portion of the cabin floor groundwards in response to generation of the force by the actuator. The tractor may be connected to an underside of the cabin floor. The tractor may comprise at least one spring, at least one rod, at least one cable and/or at least one chain.

The actuator may comprise an explosively driven actuator. The explosively driven actuator may comprise multiple explosive cartridges. Each explosive cartridge may enable a force to cause the cabin floor groundwards to be pulled groundwards on a separate occasion.

At least a portion of the cabin floor may be fixedly positioned within the vehicle. The cabin floor may be configured to flex upon actuation of the actuator. The cabin floor may be configured to return to its original position after generation of the groundwards force by the actuator. The cabin floor may be fixedly positioned within the vehicle along at least a portion of the periphery of the cabin floor. The portion of the cabin floor that is pulled groundwards upon actuation of the actuator may be located away from the periphery of the cabin floor.

According to various, but not necessarily all, embodiments there is provided an apparatus, comprising: at least one detector for detecting an explosion local to an armoured vehicle; at least one actuator, for coupling to a cabin floor of the armoured vehicle, configured to generate a force to pull at least a portion of the cabin floor groundwards; and control circuitry configured to respond to detection of an explosion local to the armoured vehicle by activating the actuator to cause the cabin floor to move groundwards.

According to various, but not necessarily all, embodiments there is provided an armoured vehicle, comprising: detecting means for detecting an explosion local to the armoured vehicle; force generation means for generating a force to cause at least a portion of the cabin floor to be pulled groundwards; and control means for responding to detection of an explosion local to the armoured vehicle by activating the force generation means to cause the cabin floor to move groundwards.

According to various, but not necessarily all, embodiments there is provided a method, comprising: detecting an explosion local to an armoured vehicle; and pulling a cabin floor of the armoured vehicle groundwards in response to detection of the explosion.

BRIEF DESCRIPTION

Some examples will now be described with reference to the accompanying drawings in which:

FIG. **1**A illustrates an example of a force versus time graph for a force generated by a bomb, a mine or an IED local to a vehicle;

FIG. **1**B illustrates an example of a force versus time graph for first and second forces generated by a blast countermeasure;

FIG. **2** illustrates a schematic of an apparatus for responding to an explosion local to a vehicle;

FIGS. **3**A and **3**B illustrate a vertical cross section and a horizontal cross section respectively of a first example of a blast countermeasure;

FIG. **3**C illustrates a vertical cross section of a second example of a blast countermeasure;

FIG. **4** illustrates a cross section of a first example of an armoured vehicle base which includes blast countermeasures;

FIG. **5** illustrates a cross section of a second example of an armoured vehicle base which includes blast countermeasures;

FIG. **6** illustrates a cross-section of a third example of an armoured vehicle base which includes blast countermeasures;

FIG. **7**A illustrates a perspective view of a floor retraction mechanism for an armoured vehicle;

FIG. **7**B illustrates a side view of the floor retraction mechanism of FIG. **7**A;

FIG. **7**C illustrates an end view of the floor retraction mechanism of FIGS. **7**A and **7**B;

FIG. **8**A illustrates a cross section of a further floor retraction mechanism for an armoured vehicle;

FIG. **8**B illustrates a detailed cross-sectional view of a mount of the further floor retraction mechanism illustrated in FIG. **8**A;

FIG. **9** illustrates a leaf spring arrangement for use in the further floor retraction mechanism illustrated in FIGS. **8**A and **8**B;

FIG. **10** illustrates a perspective view of a third example of a blast countermeasure;

FIG. **11** illustrates a perspective view of the third example of the blast countermeasure with part of its housing cutaway;

FIG. **12** illustrates a perspective view of a base of an armoured vehicle that includes blast countermeasures;

FIG. **13** illustrates a perspective view of a partial vehicle body that includes the base illustrated in FIG. **12**; and

FIG. **14** illustrates a close up of the base of the partial vehicle body illustrated in FIG. **13**.

DETAILED DESCRIPTION

An explosive event local to a land-based vehicle can cause significant trauma to a vehicle and/or a vehicle's occupants. In order to protect the occupants of the vehicle from shrapnel and blast emanating from an explosive such as a bomb, mine or improvised explosive device (IED), some vehicles comprise armour.

The armour may protect the occupants of the vehicle against injury caused directly from the shrapnel and blast effects. However, an explosion underneath or to the side of a vehicle may cause the vehicle to accelerate rapidly into the air, resulting in injury to the occupants either when being accelerated upwards or when the vehicle lands on the ground. Such an explosion may also cause the cabin floor of the vehicle to vibrate rapidly, which may injure the occupants' legs and feet if they are in contact with the cabin floor and may project unsecured items on the floor of the cabin into the air.

The detonation of a mine generates an initial shock wave which is very quickly followed by a blast wave. If the detonation occurs underneath the vehicle, these events cause damage to the vehicle and contribute to the vehicle being accelerated upwards into the air.

Immediately after the explosion occurs, there is an input of energy from the initial shock wave, the following reflected pressure waves, ejecta, and from localised very high-pressure gas. Over the next few milliseconds, the gases produced by decomposition of the explosive from the mine expand underneath the vehicle and together with other contributors (to the total impulse imparted to the vehicle) may apply a large enough force to cause the vehicle to accelerate upwards into the air and fall onto its side or top. The effect of the expanding gases can be likened to a large airbag expanding very rapidly under the vehicle.

FIG. **1**A illustrates an example of an example of a force vs time graph for an upwards force that is applied to an armoured vehicle when an explosion occurs local to the vehicle (e.g. due to detonation of a mine underneath the vehicle). It can be seen from FIG. **1**A that the force imparted to the vehicle (by the initial shock wave) is much higher over the first millisecond or so than it is following that period. It is this initial high magnitude, short duration impulse caused by the shock wave that initially loads the blast shield/belly plate positioned at the underside of an armoured vehicle and it may cause the blast shield to fail.

Embodiments of the invention advantageously mitigate the effects of a local explosion on an armoured vehicle. Some aspects relate to blast countermeasures that counteract the initial 1-2 millisecond upward force that occurs following an explosion by applying an opposing groundwards force to the blast shield of the armoured vehicle. Other aspects relate to retracting the cabin floor of the vehicle to decouple the cabin floor from the occupants' feet, in order to mitigate/prevent injury to the occupants.

FIG. **2** illustrates a vehicle protection apparatus **1000** that forms part of a land-based vehicle. The vehicle protection apparatus **1000** mitigates/prevents the damage caused to a vehicle by an explosion by counteracting the forces generated by the explosion and stabilising the vehicle in response to the explosion. It may, advantageously, enable injury to the vehicle's occupants to be prevented or limited and enable the vehicle to remain upright and in fighting condition. This is explained in further detail below.

The vehicle protection apparatus **1000** illustrated in FIG. **2** may be applied to a vehicle during manufacture or post manufacture. The apparatus **1000** may, for example, be a kit of parts. The vehicle may be a land-based armoured vehicle. For example, the vehicle may be a civilian car, a modified sports utility vehicle, a lightweight special forces vehicle or a larger military armoured vehicle such as a personnel carrier.

The apparatus **1000** comprises one or more blast countermeasures **200**, such as those described below in relation to FIGS. **3**A to **6** and FIGS. **10** to **14** below, one or more floor retraction mechanisms **300** such as those described below in relation to FIGS. **7**A to **14**, one or more detectors **18**, control circuitry **12** and memory **14**. In some implementations, the apparatus **1000** includes the one or more blast countermeasures **200** and the floor retraction mechanism(s) **300**. In some of these implementations, such as those discussed below in relation to FIGS. **10** to **14**, the blast countermeasures **200** might also provide at least part of the floor retraction mechanism **300**. In other implementations, the apparatus **1000** might include the floor retraction mechanism(s) **300** and not the one or more blast countermeasures **200**, or it might include the one or more blast countermeasures **200** and not the floor retraction mechanism(s) **300**. In all of these implementations, the one or more rocket motors **100** are optional.

If present, the rocket motors **100** are configured to apply a groundwards force to the vehicle when an explosion occurs local to the vehicle. The force applied by the rocket motors **100** is intended to counter the longer-term upwards forces mentioned above that would otherwise cause the vehicle to accelerate rapidly into the air. The rocket motors **100** might, for example, be the same or similar to the "linear rocket motors" described in PCT patent application publication number WO 2014/111709. Additionally or alternatively, mass ejection devices may be used to apply the groundwards force to the vehicle, such as those described in PCT patent application number WO 2011/148118.

The blast countermeasures **200** are configured to apply a groundwards force to a blast shield of the vehicle when an explosion occurs local to the vehicle (e.g. underneath the vehicle). FIG. **1**B illustrates an example of a force versus time graph for first and second forces generated by a blast countermeasure. This is discussed below, in conjunction with the blast countermeasures **200** illustrated in FIGS. **3**A to **6** and **10** to **14**.

Each floor retraction mechanism **300** is configured to retract a cabin floor of the vehicle when an explosion occurs local to the vehicle (e.g. underneath the vehicle). Different floor retraction mechanisms **300** are described in detail below in relation to FIGS. **7**A to **14**.

The control circuitry **12** may, for example, be or comprise a single processor or multiple processors.

The control circuitry **12** is configured to receive inputs from the one or more detectors **18**. The control circuitry **12** is configured to provide outputs which cause initiation of: one, some or all of the rocket motors **100**; one, some or all of the blast countermeasures **200**; and/or the floor retraction mechanism(s) **300**.

The control circuitry **12** is also configured to write to and read from memory **14**. The control circuitry **12** may control the initiation of the rocket motors **100**, the blast countermeasures **200** and/or the floor retraction mechanism(s) **300** in accordance with response data **16** stored in the memory **14**. The response data **16** might, for example, specify how the rocket motors **100**, the blast countermeasures **200** and/or the floor retraction mechanism(s) **300** should be controlled depending upon the inputs provided by the detectors **18**. Such inputs may, for example, indicate the directivity and the magnitude of the blast shock wave caused by an explosion.

It will be appreciated by those skilled in the art that FIG. **2** is a functional schematic. In this regard, it should be recognised that intervening elements (such as additional circuitry) may be positioned between the control circuitry **12** and each of the one or more rocket motors **100**, the one or more blast countermeasures **200**, the floor retraction mechanism(s) **300**, the one or more detectors **18** and the memory **14**.

The control circuitry **12** may operate under the control of computer program instructions stored in the memory **14**. In an alternative implementation, the control circuitry **12** and/or the memory **14** may be provided by a dedicated application specific integrated circuit (ASIC). In such an implementation, it may be that no computer program is required.

The detectors **18** are for detecting that an explosion has occurred local to (for example, underneath) a vehicle. The detectors **18** may be any type of detectors and may, for example, include: one or more pressure detectors, one or more temperature detectors and/or one or more light detectors.

The pressure detectors may, for example, be piezoelectric pressure detectors. Advantageously, piezoelectric pressure detectors operate effectively in adverse weather and ground conditions. Alternatively or additionally, the detectors **18** may include one or more break wire detectors. An explosion may cause a circuit of such a break wire detector to break, causing the break wire detector to provide an input to the processor **12**. Alternatively or additionally, the detectors **18** may include one or more ionisation detectors for detecting ionised particles that result from an explosion. Alternatively or additionally, the detectors **18** may comprise one or more electromagnetic pulse detectors for detecting an electromagnetic pulse resulting from an explosion. Alternatively or additionally, the detectors **18** may comprise one or more accelerometers and/or one or more gyroscopes. Alternatively or additionally, the detectors **18** may comprise one or more strain gauges.

In operation, when an explosion occurs which is external to and local to a land-based vehicle (such as underneath the vehicle), the explosion causes a blast shock wave. The detectors **18** detect that an explosion has occurred local to the vehicle and provide inputs to the control circuitry **12** which are indicative that an explosion has occurred. The control circuitry **12** analyses the inputs provided by the detectors **18** and determines that an explosion has occurred. The control circuitry **12** then responds to the inputs provided by the detectors **18** by initiating the rocket motors **100** (if present), the blast countermeasures **200** (if present) and the floor retraction system(s) **300** (if present). The rocket motors **100**, the blast countermeasures **200** and/or the floor retraction system **300** may, for example, be initiated in less than a millisecond of the explosion occurring.

Initiation of the blast countermeasures **200** causes the blast countermeasures **200** to apply a groundwards force to the blast shield of the vehicle, mitigating the initial large upward forces generated by the blast shock wave of the explosion. Initiation of the rocket motors **100** causes a groundwards force to be applied to the vehicle to urge the vehicle towards ground and mitigates the longer term and lower magnitude upward forces generated by the blast shock wave from the explosion. Initiation of the floor retraction mechanism(s) **300** causes the cabin floor in the vehicle to retract, decoupling the cabin floor from the occupants' feet thereby mitigating or preventing injury to the occupants.

In some circumstances, depending on the nature of the vehicle and the explosive threat(s) that the vehicle is expected to face, the rocket motors **100** may be unnecessary. That is, the blast countermeasures **200** may be able to provide a groundwards force of a large enough magnitude for a sufficiently long period of time to adequately mitigate the upward forces generated by the blast shock wave of the explosion.

FIGS. **3**A and **3**B illustrate a vertical cross section and a horizontal cross section respectively of a first example of a blast countermeasure **200*a***. The blast countermeasure **200*a*** may be for location between a blast shield of an armoured vehicle and a cabin floor of the armoured vehicle. In this example, the blast countermeasure **200*a*** is a cube shape with a square cross section or a rectangular prism shape with a rectangular cross-section.

The blast countermeasure **200*a*** comprises a housing **210** which includes a plurality of side walls **211**-**214**, a base (wall) **215**, an upper wall/roof **216** and an optional inner wall **217**. The blast countermeasure **200** might be a relatively compact device in order to enable it to fit into the space between the cabin floor and the blast shield of an armoured vehicle. For example, the depth of the blast countermeasure **200*a*** (in this example, the distance between the base **215** and the upper wall **216**), might be less than 150 millimetres, such as less than 100 millimetres. It could, for example, be about 75 millimetres.

The length and the width of the blast countermeasure **200*a*** (in this example, the distance between opposing side walls **211**, **212** or **213**, **214**) might be less than 300 millimetres, such as less than 200 millimetres. It could, for example, be about 150 millimetres.

In this example, two of the side walls **211**, **212** and the inner wall **217** each include one or more vents. The other side walls **213**, **214** might or might not include one or more vents.

The blast countermeasure **200*a*** includes at least one explosive **202** which, in this example, is provided by detonating cord and high explosive. In other examples the explosive might consist of solely detonating cord, for example. The blast countermeasure **200*a*** includes a detonator **203** for detonating the explosive(s) **202**. FIGS. **3**A and **3**B also illustrate an electrical connector/cable **201** for connecting the detonator **203** to an initiator. The control circuitry **12** is configured to provide an output to the initiator, which, in turn, is configured to provide an output to the detonator **203**.

The blast countermeasure **200** further comprises a mass **204**, a shock wave attenuator (a first energy absorbing material/means) **206**, a further shock wave attenuator (a second energy absorbing material/means) **208** and a reflector **218**. The mass **204** is different from the reflector **218** in this example and is formed from one or more solids and might include one or more liquids. In this regard, the mass **204** may be referred to as a "non-gaseous mass".

Each of the shock wave attenuator **206** and the further shock wave attenuator **208** might be formed from one or more resilient, energy absorbing materials such as particulate matter contained within resin. An example of this is the TABRE™ material. The shock wave attenuator **206** and the further shock wave attenuator **208** might each be made from the same material(s), or different materials.

The reflector **218** may be made from one or more metals and may be substantially planar in shape. The reflector **218** is positioned at least partially between the explosive(s) **202** and the mass **204**. The purpose of the reflector **218** is to reflect the shock wave, that is generated by detonation of the explosion, groundwards. This increases the magnitude of the downwards force provided by the generated shock wave.

The explosive(s) **202** is/are provided on the base **215** of the illustrated example. For example, detonating cord may be wound in a circular configuration and placed on the base **215**. A high explosive might or might not be placed on the detonating cord. The explosive **202** is at least partially located between the mass **204** and the base **215**. In some examples, the mass **202** may be suspended within the housing **210** such that there is an air gap between the explosive **202** and the mass **204**. In other examples, there might be no such air gap.

The mass **204** is at least partially located between the shock wave attenuator **206** and the explosive **202**. In some examples, there may be an air gap between the mass **204** and the shock wave attenuator **206**. In other examples, there may be no such air gap.

FIG. **3**C illustrates a vertical cross-section of a second example of a blast countermeasure **200***b*. The second example of the blast countermeasure **200***b* differs from the first example **200***a* in that it is cylindrical in shape and therefore has a single side wall **211**. The single side wall includes a number of vents in the form of perforations in the side wall **211**. One or more supports **219** may be provided at intervals around the side wall **211** to help to hold the further shock wave attenuator **208** in position when the explosive **202** is detonated. Corresponding supports **219** might also be present in the FIG. **3**A/**3**B embodiment.

FIG. **4** illustrates a cross section of a first example of an armoured vehicle base which includes blast countermeasures **200**, such as those **200***a*, **200***b* illustrated in FIGS. **3**A, **3**B and **3**C. The armoured vehicle includes a cabin floor **240** and a blast shield/belly plate **250**. The cabin floor **240** may be the floor of the front cabin of the armoured vehicle, the rear cabin of the armoured vehicle or both. That is, the floor **240** is the floor upon which the passengers and/or the driver of the armoured vehicle would place their feet when sitting or standing in the vehicle. The blast shield **250** is located at the underside of the armoured vehicle, underneath the cabin floor **240**.

In the example illustrated in FIG. **4**, a plurality of elongate strengthening members **260** are provided to strengthen the resistance of the blast shield **250** to an explosion. FIG. **4** shows a cross-section of each elongate strengthening member **260**, where the elongate length of each member **260** is directed into and out of the page. The dimension directed into and out of the page in FIG. **4** might be the widthwise dimension of the armoured vehicle.

The elongate strengthening members **260** might be formed, at least in part, from a composite material such as carbon fibre. The blast shield **250** and/or the elongate strengthening members **260** may take the same form as those disclosed in PCT patent application publication number WO 2019/030465, for example.

In FIG. **4**, each of the blast countermeasures **200** is positioned on an upper surface of the blast shield **250**, and is located between the cabin floor **240** and the blast shield **250**. That is, the base **215** of each of the blast countermeasures **200** is positioned on the blast shield **250**. Each of the blast countermeasures **200** is located between the cabin floor **240** and the blast shield **250** in a first, vertical, dimension.

If the armoured vehicle comprises elongate strengthening members **260**, at least some of the blast countermeasures **200** may be positioned in between adjacent (first and second) elongate strengthening members, as shown in FIG. **4**.

In some implementations, each of the blast countermeasures **200**, **200***a*, **200***b* might not have the same configuration as in FIGS. **3**A to **3**C in which each of the blast countermeasures **200**, **200***a*, **200***b* has its own roof/upper wall **216**, its own reflector **218** and/or its own shock wave attenuator **206**. For example, instead, the upper wall **216**, the reflector **218** and/or the shock wave attenuator **206** might extend across multiple blast countermeasures **200**, **200***a*, **200***b*, between the cabin floor **240** and the blast countermeasures **200**, **200***a*, **200***b*.

FIG. **5** illustrates a cross-section of a second example of an armoured vehicle base which includes blast countermeasures **200**. The blast countermeasures **200** may be the same as those illustrated in FIGS. **3**A to **3**C. The example in FIG. **5** differs from the example in FIG. **4** in that at least one longitudinal elongate strengthening member **260***a* is provided in addition to the widthwise elongate strengthening members **260**. The length of the longitudinal elongate strengthening member(s) **260***a* is/are substantially perpendicular to the length of the widthwise elongate strengthening members **260**.

In each of the examples illustrated in FIGS. **4** and **5**, the armoured vehicle base might comprise a further blast shield that is located, at least in part, between the cabin floor **240** and the blast countermeasures **200**. FIG. **6** illustrates such an instance, in which a second blast shield **250***b* has been added to the example illustrated in FIG. **4**. The first blast shield **250***a* is located at the underside of the vehicle. The second blast shield **250***a* is located, at least in part, between the cabin floor **240** and the blast countermeasures **200**. The (upper) second blast shield **250***b* might be attached to the elongate strengthening members **260**, forming a sandwich structure with the (lower) first blast shield **250***a*.

In use, when an explosion local to (and external to) the armoured vehicle occurs (for example, a mine or an IED blast), it is initially detected by the detectors **18**. The control circuitry **12** receives the inputs from the detectors **18** and determines how to respond to the inputs by referring to the response data **16**. The control circuitry **12** then provides outputs to activate the blast countermeasures **200** based on the response data **16**. For example, the response data **16** might indicate which blast countermeasures **200** to activate in particular circumstances, depending upon, for example, the magnitude and directivity of the blast shock wave.

The outputs provided by the control circuitry **12** activate one, some or all of the blast countermeasures **200**, causing the detonator **203** to detonate the explosive **202**. Detonation of the explosive **202** generates an omnidirectional shock wave within the housing **210**. The force generated by the detonation of the explosive **202** produces the shock wave which is at least partially reflected groundwards by the reflector **218**. The shock wave also urges the mass **204** upwards, which in turn generates a reactionary groundwards/downwards force on the reflector **218** that is transmitted through to the base **215** of the blast countermeasure **200**.

Due to conservation of momentum, the groundwards impulse that is generated by detonation of the explosive is thought to be equal to the upwards impulse that is generated by detonation of the explosive **202**. However, the nature of the impulses is different. The shock wave attenuator **206** slows down the shock wave generated by the explosion when the shock wave is travelling in an upwards direction. High pressure gas is also generated by detonation of the explosive, which generates pressure within the housing **210**. The shock wave attenuator **206** also slows down the upwards movement of the reflector **218** and mass **204** that occurs in response to the shock wave and the generated gas pressure, due to the positioning of the shock wave attenuator **206** above the explosive **202**, the reflector **218** and the mass **204**. The shock wave attenuator **206** is a crushable material which crushes under the upwards force applied by the reflector **218** and the mass **204**. The slowing down of the shock wave, the mass **204** and the reflector **218** in an upwards direction reduces the magnitude of the upwards force that is generated, causing it to be applied to the vehicle over a greater period of time than the downwards force. This is illustrated schematically in FIG. **1**B, which illustrates a first, groundwards force **31** that is applied to the vehicle by a blast countermeasure **200** and a second, upwards force **32** that is applied to the vehicle by the blast countermeasure **200**.

The reflected shock wave and the reactionary force (provided by urging the mass **204** upwards) act on the (lowermost) blast shield **250**, providing a high magnitude, short duration groundwards force that counteracts the upwards force generated by the mine or IED blast local to the vehicle, mitigating or preventing the upwards acceleration of the armoured vehicle into the air and maintaining the vehicle upright and in fighting condition.

Absorption of the portion of shock wave that is directed upwards by the shock wave attenuator **206** helps to prevent the explosion which occurs within the housing **210** of the blast countermeasure **200** from having an adverse impact on the cabin floor **240**. Depending on the nature of the blast countermeasure **200** and the forces generated by it, it might be advantageous to have an upper blast shield **250***b* (as illustrated in FIG. **6**) to protect the cabin floor **240** and the occupants of the cabin against the portion of shock wave that is directed upwards towards the cabin floor **240**.

The portion of the shock wave that is directed in the horizontal dimension is attenuated, at least in part, by the further shock wave attenuator **208**. The vents provided in the side wall(s) **211**, **212** are arranged to relieve pressure which is generated within the housing by detonation of the explosive **202**.

The blast countermeasures **200** may be activated simultaneously or sequentially in order to provide a groundwards impulse that appropriately mitigates the upward force generated by the explosion local to the vehicle.

FIG. **7**A illustrates a perspective view of a first example **300***a* of a floor retraction mechanism **300**. This example may be appropriate for use in a rear cabin of an armoured vehicle, for instance, in which passengers are carried. FIGS. **7**B and **7**C illustrate side and end views respectively of the floor retraction mechanism **300***a* illustrated in FIG. **7**A. In the illustrated example, a plurality of elongate strengthening members **260** are provided on the blast shield **250**, as described above in relation to FIG. **3**.

The floor retraction mechanism **300***a* comprises at least one actuator **270**, which is coupled to the cabin floor **240**, for generating a force that causes at least a portion of the cabin floor to be pulled groundwards.

In this example, the actuator **270** is coupled to the cabin floor **240** using at least one tractor **275**, one or more pulleys **280** and an elongate connecting member **285**. The tractor(s) **275** might comprise one or more chains and/or one or more cables. In other examples, the tractor(s) **275** might be one or more rods. The tractor **275** is coupled to the actuator **270** (such as directly connected to the actuator **270**) and routed from the actuator **270**, through the one or more pulleys **280** to the elongate connecting member **285**. The elongate connecting member **285** is optional and potentially enables a pulling force to be more uniformly applied along or across the cabin floor **240**. In the illustrated example, the tractor **275** is connected/coupled to the underside of the cabin floor **240** via the elongate connecting member **285**.

The actuator **270** is an explosively driven actuator. That is, an explosion within the actuator **270** generates a force. In some implementations, the actuator **270** might be configured to receive (or comprise) multiple explosive cartridges, where each explosive cartridge enables a force to be generated to cause a portion of the cabin floor **240** to be pulled groundwards on a separate occasion. This advantageously enables the floor actuation mechanism **300***a* to be activated/fired on several separate occasions.

In use, when an explosion occurs local to the armoured vehicle, the explosion is detected by the detectors **18**. The control circuitry **12** receives inputs from the detectors and responds by sending an output which causes the actuator **270** to actuate. Actuation of the actuator **270** generates a force which causes at least a portion of the cabin floor **240** to be pulled groundwards. In this instance, when the actuator **270** actuates, it causes the actuator **270** to pull the tractor **275** through the one or more pulleys **280**, increasing the tension in the tractor **275** and pulling at least a portion of the cabin floor **240** groundwards.

In some examples, the whole of the cabin floor **240** is able to move and is pulled groundwards. In other examples, only a portion of the cabin floor **240** is configured to move groundwards. For example, the cabin floor **240** might be partially fixed within the vehicle and might flex when it is pulled groundwards. The cabin floor **240** might be fixedly positioned within the armoured vehicle along at least a portion of the periphery of the cabin floor **240**. The portion of the cabin floor **240** that is pulled groundwards might be located away from the periphery of the cabin floor **240** and might, for example, be at or close to the centre of the cabin floor **240**. The cabin floor **240** might automatically return to its original position a period of time after the actuator **270** was actuated. For example, the cabin floor **240** might be resilient in nature and might “spring” back into its original position.

Advantageously, groundwards movement of the cabin floor **240** in response to the detection of an explosion may mitigate or prevent damage to the feet of personnel situated within the vehicle when the explosion occurs. For example, the blast shock wave generated by an explosion local to a vehicle, such as underneath a vehicle, might be transmitted through a vehicle to the cabin floor **240** such that the cabin floor **240** begins to vibrate vigorously at high speed. By de-coupling the vibrating cabin floor **240** from the feet of those inside, injury is mitigated or prevented.

The floor retraction mechanism **300***a* need not have the same configuration as that illustrated in FIGS. **7**A, **7**B and **7**C. Instead, for example, of the actuator(s) **270** pulling the tractor(s) **275** horizontally in the manner illustrated in those figures, the actuator **270**(s) might pull the tractor(s) **275** directly groundwards/downwards.

FIGS. **8**A and **8**B illustrate a second example **300***b* of the floor retraction mechanism **300**. The second example of the floor retraction mechanism **300***b* might, for example, be suitable for use in a front cabin of an armoured vehicle in which the driver of the armoured vehicle may be located. The armoured vehicle includes a cabin floor **1240** and a lower surface **1241**. The lower surface **1241** might be the original cabin floor **1241** in the vehicle and the cabin floor **1240** might be a new, replacement cabin floor. The cabin floor **1240** has a reinforcement **1242**. An actuator **1270** is provided for causing the cabin floor **1240** to be pulled groundwards. The actuator **1270** is coupled to the cabin floor **1240** via the reinforcement **1242**.

One or more tractors **1275** are provided couples the actuator **1270** to the cabin floor **1240**. In this example, the tractor(s) **275** might be provided by at least one Belleville spring or a leaf spring arrangement, for example. The tractor/spring **1275** is coupled to the lower surface **1241** by one or more mounts **1290**.

FIG. **8**B illustrates a mount **1290** in more detail. The mount **1290** may include one or more joints **1294**, such as twin spherical joints or twin single axis hinges to enable the spring **1275** to move to retract the cabin floor **1240**.

In this example the actuator **1270** includes a detonator **1272** contained within a separator **1274**. The separator **1274** might be a ceramic block. The separator **1274** separates the spring **1275** from the cabin floor **1240** and holds/maintains the spring **1275** in a pre-tensioned configuration. The actuator **1270** is actuated by detonating the detonator **1264**, which causes the separator **1274** to cease holding the spring **1275** in its pre-tensioned configuration. In this example, detonation of the detonator **1262** causes the separator **1274** to disintegrate. Without the presence of the separator **1274**, the tension in the spring **1275** causes the spring **1275** pulls the cabin floor **1240** groundwards (whilst the connection between the spring **1275** and the lower surface **1241** is maintained by the mounts **1290**).

FIG. **9** illustrates a leaf spring arrangement that may be suitable for use as the tractor/spring **1275** in the example illustrated in FIGS. **8**A and **8**B. The leaf spring arrangement comprising a first spring **1292** and a second leaf spring **1293**, which crosses the first leaf spring **1292**.

FIG. **10** illustrates a perspective view of a third example of a blast countermeasure **200***c*. FIG. **11** illustrates a perspective view of the third example of the blast countermeasure **200***c* with part of its housing **210** cutaway.

The illustrated blast countermeasure **200***c* is a rectangular prism shape with a rectangular cross-section, but in other implementations it might be different shape, such as a cube shape with a square cross-section or cylindrical shape with a circular cross-section.

The third example of the blast countermeasure **200***c* is similar to the first and second examples of the blast countermeasure **200***a*, **200***b* in that it comprises a housing **210**, at least one explosive **202**, a detonator for detonating the explosive, a mass **204** and a shock wave attenuator **206**.

The housing **210** includes at least one wall **211**-**216** in the form of a plurality of side walls **211**-**214**, a base (wall) **215** and an upper wall/roof **216**. The third example of the blast countermeasure **200***c* might be a relatively compact device in order to enable it to fit into the space between the adjacent blast shields **250***a*, **250***b* in the base of an armoured vehicle, as described above in relation to FIG. **6**. For example, the depth of the blast countermeasure **200***c* (in this example, the distance between the base **215** and the upper wall **216**), might be less than 150 millimetres, such as less than 100 millimetres. It could, for example, be about 75 millimetres.

The length and the width of the blast countermeasure **200***a* (in this example, the distance between opposing side walls **211**, **212** or **213**, **214**) might be less than 300 millimetres, such as less than 200 millimetres. It could, for example, be about 150 millimetres. One, some or all of the walls **211**-**216** might each include one or more vents.

In this example, the explosive **202** is sheet explosive, although that need not be the case in every implementation. The sheet explosive may be formed, at least in part, from high explosive. The explosive **202** may be detonated by a detonator. The control circuitry **12** of the vehicle protection apparatus **1000** is configured to provide an output to an initiator, which is in turn configured to provide an output to the detonator.

In the third example of the blast countermeasure **200***c*, a separate reflector is not provided. Instead, a lower surface of the mass **204** acts to reflect the shock wave produced by detonation of the explosive **202**. The mass **204** may be formed from one or more solids and might include one or more liquids. In this regard, the mass **204** may be referred to as a "non-gaseous mass". In the illustrated example, the mass **204** is formed from steel.

The shock wave attenuator **206** in the illustrated example is formed from one or more metals, such as steel or aluminium and has a honeycomb structure. Alternatively, as explained above in relation to the first example of the blast countermeasure **200***a*, it might be formed from particulate matter contained within resin such as the TABRE™ material.

The explosive(s) **202** is/are provided on the base **215** of the illustrated example. The mass **204** is at least partially located between the shock wave attenuator **206** and the explosive **202**. In some examples, there may be an air gap between the mass **204** and the shock wave attenuator **206**. In other examples, there may be no such air gap.

The third example of the blast countermeasure **200***c* functions in a similar manner to the first and second examples **200***a*, **200***b* described above. A force generated by detonation of the explosive **202** produces an omnidirectional shock wave which is at least partially reflected groundwards by the mass **204**. The shock wave and the gas pressure that results from the detonation of the explosive **202** also urges the mass **204** upwards, which in turn generates a reactionary groundwards/downwards force that is transmitted through to the base **215** of the blast countermeasure **200***c*.

As explained above, the shock wave attenuator **206** slows down the shock wave generated by the explosion and slows down the mass **204** as the mass **204** crushes the shock wave attenuator **206**, when the shock wave and the mass **204** are travelling in an upwards direction, due to its positioning above the explosive **202**. This reduces the magnitude of the upwards force that is generated, causing it to be applied to the vehicle over a greater period of time than the downwards force. This is illustrated schematically in FIG. **1**B, which illustrates a first, groundwards force **31** that is applied to the vehicle by a blast countermeasure **200** and a second, upwards force **32** that is applied to the vehicle by the blast countermeasure **200***c*.

The reflected shock wave and the reactionary force (provided by urging the mass **204** upwards) act on a (lowermost) blast shield **250***a* of the vehicle, providing a high magnitude, short duration groundwards force that counteracts the upwards force generated by the mine or IED blast local to the vehicle, mitigating or preventing the upwards acceleration of the armoured vehicle into the air and maintaining the vehicle upright and in fighting condition. The conversion of (i) the kinetic energy of the shock wave and the mass **204** and (ii) the gas pressure generated by the detonation of the explosive **202** into (iii) deformation of the shock wave attenuator **206** helps to prevent the explosion which occurs within the housing **210** of the blast countermeasure **200** from having an adverse impact on the cabin floor **240** of the armoured vehicle.

An upper blast shield **250***b* (as illustrated in FIG. **6**) to protect the cabin floor **240** and the occupants of the cabin against upward forces generated by the portion of shock wave that is directed upwards may be provided.

The third example of the blast countermeasure **200***c* may also configured such that detonation of the explosive **202** causes the blast countermeasure **200***c* to pull the cabin floor **240** groundwards. In effect, the blast countermeasure **200***c* combines the functionality of the blast countermeasures **200***a*, **200***b* described above and that of the actuator **270** of the floor retraction mechanism **300***a* described above. The third example of the blast countermeasure **200***c* is an example of an explosively driven actuator.

The third example of the blast countermeasure **200***c* may be coupled to the cabin floor **240** of an armoured vehicle such that activation of the blast countermeasure **200***c* causes the cabin floor to be pulled groundwards. In this regard, the third example of the blast countermeasure **200***c* may further comprise coupling means in the form of one or more levers **231**, **232** that are arranged to couple the blast countermeasure **200***c* to the cabin floor **240**. If the armoured vehicle has an upper blast shield **250***b*, such as that illustrated in FIG. **6**, the one or more levers **231**, **232** may be routed through the upper blast shield **250***b* to the cabin floor **240**, or otherwise coupled to the cabin floor **240**.

In the example illustrated in FIG. **10**, a plurality of levers **231**, **232** are provided. Each lever extends through an aperture **251** in the housing **10** and is positioned, in part, between the mass **204** and the shock wave attenuator **206**. A portion of each lever **231**, **232** is positioned on a portion of an upper surface of the mass **204**. Each lever **231**, **232** comprises a hinge **241**, about which the lever **231**, **232** is configured to pivot.

Detonation of the explosive **202** causes an upwards force to be applied to the mass **204**, which in turn applies an upwards force to the portion of each lever **231**, **232** that is positioned on the mass **204**. This causes the levers **231**, **232** to pivot about the hinges **241** and pull the cabin floor **240** groundwards.

The detonation of the explosive **202** therefore causes the blast countermeasure **200***c* to apply the groundwards force to the blast shield **250***a* and pull the cabin floor **240** groundwards substantially simultaneously.

FIG. **12** illustrates a perspective view of the base of an armoured vehicle that includes the blast countermeasures **200***c*. The base illustrated in FIG. **12** is similar to that illustrated in FIG. **6**, but differs in that no upper blast shield **250***b* is shown for clarity purposes. Such an upper blast shield **250***b* might or might not be present.

The vehicle base illustrated in FIG. **12** is shown to include an optional elongate connecting member **285**, which is similar to that described above in relation to FIGS. **7**A to **7**C. In the illustrated example, the levers **231**, **232** of each blast countermeasure **200***c* are connected to the elongate connecting member **285** that is in turn connected to the cabin floor **240**. One or more intermediate connecting members could exist between the levers **231**, **232** and the elongate connecting member **285**, and/or between the elongate connecting member **285** and the cabin floor **240**.

FIG. **13** illustrates a perspective view of a partial vehicle body that includes the base illustrated in FIG. **12**. FIG. **14** illustrates a close up of the base of the partial vehicle body illustrated in FIG. **13**.

References to "control circuitry" above should be understood to encompass not only computers having different architectures such as single/multi-processor architectures and sequential (Von Neumann)/parallel architectures but also specialized circuits such as field-programmable gate arrays (FPGA), application specific circuits (ASIC), signal processing devices and other processing circuitry. References to computer program instructions above should be understood to encompass software for a programmable processor or firmware such as, for example, the programmable content of a hardware device whether instructions for a processor, or configuration settings for a fixed-function device, gate array or programmable logic device, etc.

Where a structural feature has been described, it may be replaced by means for performing one or more of the functions of the structural feature whether that function or those functions are explicitly or implicitly described.

The term 'comprise' is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising Y indicates that X may comprise only one Y or may comprise more than one Y. If it is intended to use 'comprise' with an exclusive meaning then it will be made clear in the context by referring to "comprising only one" or by using "consisting".

In this description, reference has been made to various examples. The description of features or functions in relation to an example indicates that those features or functions are present in that example. The use of the term 'example' or 'for example' or 'can' or 'may' in the text denotes, whether explicitly stated or not, that such features or functions are present in at least the described example, whether described as an example or not, and that they can be, but are not necessarily, present in some of or all other examples. Thus 'example', 'for example', 'can' or 'may' refers to a particular instance in a class of examples. A property of the instance can be a property of only that instance or a property of the class or a property of a sub-class of the class that includes some but not all of the instances in the class. It is therefore implicitly disclosed that a feature described with reference to one example but not with reference to another example, can where possible be used in that other example as part of a working combination but does not necessarily have to be used in that other example.

Although examples have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the claims. For example, a blast countermeasure **200**, **200***a*, **200***b*, **200***c* need not be placed between a cabin floor **240** and a blast shield **250** of a vehicle. In some instances, one or more blast countermeasures **200**, **200***a*, **200***b*, **200***c* could be positioned on the exterior of a vehicle, such as an armoured vehicle.

A blast countermeasure **200**, **200***a*, **200***b*, **200***c* need not include a shock wave attenuator **206** or a further shock wave attenuator **208**. In instances where a blast countermeasure **200**, **200***a*, **200***b*, **200***c*, is positioned on the exterior of a vehicle, attenuation of an upwardly directed portion of a shock wave generated by the blast countermeasure might be unnecessary, because that portion of the shock wave might have little to no impact on the vehicle and its occupants.

Even in circumstances where the blast countermeasure **200**, **200***a*, **200***b*, **200***c* is positioned between the cabin floor **240** and the blast shield **250**, the shock wave attenuator **206** and a further shock wave attenuator **208** might not be necessary. Presence of the reflector **218** alone or a combination of the reflector **218** and the mass **204** might be enough to reduce the impact of the portion of the shock wave that is initially directed upwards towards the cabin floor **240** following detonation of the explosive **202**.

In some embodiments, the actuator **270** that is configured to generate a floor to cause the cabin floor **240** of a vehicle to retract might be a blast countermeasure **200**, **200***a*, **200***b*, **200***c*. The blast countermeasure **200**, **200***a*, **200***b*, **200***c* might simultaneously provide a groundwards force to a vehicle (e.g. a blast shield **250** of a vehicle) and provide a force to retract the cabin floor **240**.

The separator **1274** might not be a ceramic block and might not completely disintegrate when the actuator **1270** is actuated.

Alternative coupling means, different from the levers **231**, **232**, may be provided to couple the blast countermeasures **200***c* to the cabin floor **240**.

Features described in the preceding description may be used in combinations other than the combinations explicitly described above.

Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

Although features have been described with reference to certain examples, those features may also be present in other examples whether described or not.

The term 'a' or 'the' is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising a/the Y indicates that X may comprise only one Y or may comprise more than one Y unless the context clearly indicates the contrary. If it is intended to use 'a' or 'the' with an exclusive meaning then it will be made clear in the context. In some circumstances the use of 'at least one' or 'one or more' may be used to emphasis an inclusive meaning but the absence of these terms should not be taken to infer an exclusive meaning.

The presence of a feature (or combination of features) in a claim is a reference to that feature or (combination of features) itself and also to features that achieve substantially the same technical effect (equivalent features). The equivalent features include, for example, features that are variants and achieve substantially the same result in substantially the same way. The equivalent features include, for example, features that perform substantially the same function, in substantially the same way to achieve substantially the same result.

In this description, reference has been made to various examples using adjectives or adjectival phrases to describe characteristics of the examples. Such a description of a characteristic in relation to an example indicates that the characteristic is present in some examples exactly as described and is present in other examples substantially as described.

Whilst endeavouring in the foregoing specification to draw attention to those features believed to be of importance it should be understood that the applicant may seek protection via the claims in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not emphasis has been placed thereon.

I claim:

1. An armoured vehicle, comprising:
- at least one detector for detecting an explosion local to the armoured vehicle;
- a cabin floor;
- at least one actuator, coupled to the cabin floor, for generating a force to cause at least a portion of the cabin floor to be pulled groundwards; and
- control circuitry configured to respond to detection of an explosion local to the armoured vehicle by activating the actuator to cause the cabin floor to move groundwards.

2. The armoured vehicle of claim **1**, further comprising a tractor configured to pull at least a portion of the cabin floor groundwards in response to generation of the force by the at least one actuator.

3. The armoured vehicle of claim **2**, wherein the tractor is connected to an underside of the cabin floor.

4. The armoured vehicle of claim **2**, wherein the tractor comprises at least one spring, at least one rod, at least one cable and/or at least one chain.

5. The armoured vehicle of claim **1**, wherein the at least one actuator comprises an explosively driven actuator.

6. The armoured vehicle of claim **5**, wherein the explosively driven actuator comprises multiple explosive cartridges, each explosive cartridge enabling a force to be generated to cause at least a portion of the cabin floor to be pulled groundwards on a separate occasion.

7. The armoured vehicle of claim **1**, wherein at least a portion of the cabin floor is fixedly positioned within the vehicle.

8. The armoured vehicle of claim **7**, wherein the cabin floor is configured to flex upon actuation of the at least one actuator.

9. The armoured vehicle of claim **8**, wherein the cabin floor is configured to return to its original position after generation of the groundwards force by the actuator.

10. The armoured vehicle of claim **7**, wherein the cabin floor is fixedly positioned within the vehicle along at least a portion of the periphery of the cabin floor, and the portion of the cabin floor that is pulled groundwards upon actuation of the at least one actuator is located away from the periphery of the cabin floor.

11. An apparatus, comprising:
- at least one detector for detecting an explosion local to an armoured vehicle;
- at least one actuator, for coupling to a cabin floor of the armoured vehicle, configured to generate a force to cause at least a portion of the cabin floor to be pulled groundwards; and
- control circuitry configured to respond to detection of an explosion local to the armoured vehicle by activating the actuator to cause the cabin floor to move groundwards.

12. A method, comprising:
- detecting an explosion local to an armoured vehicle; and
- pulling a cabin floor of the armoured vehicle groundwards in response to detection of the explosion.

13. The apparatus of claim **11**, further comprising a tractor for pulling at least a portion of the cabin floor groundwards in response to generation of the force by the at least one actuator.

14. The apparatus of claim **13**, wherein the tractor is for connection to an underside of the cabin floor.

15. The apparatus of claim **13**, wherein the tractor comprises at least one spring, at least one rod, at least one cable and/or at least one chain.

16. The apparatus of claim **11**, wherein the at least one actuator comprises an explosively driven actuator.

17. The apparatus of claim **16**, wherein the explosively driven actuator comprises multiple explosive cartridges, each explosive cartridge enabling a force to be generated to cause at least a portion of the cabin floor to be pulled groundwards on a separate occasion.

18. The apparatus of claim **11**, wherein the cabin floor is configured to flex upon actuation of the at least one actuator.

19. The apparatus of claim **18**, wherein the cabin floor is configured to return to its original position after generation of the groundwards force by the actuator.

20. An armoured vehicle, comprising:
- a blast shield located at the underside of the armoured vehicle;

at least one detector for detecting an explosion local to the armoured vehicle;

a cabin floor;

at least one actuator, coupled to the cabin floor, for generating a force to cause at least a portion of the cabin floor to move groundwards relative to the blast shield while the actuator remains coupled to the cabin floor; and

control circuitry configured to respond to detection of an explosion local to the armoured vehicle by activating the actuator to cause the cabin floor to move groundwards.

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